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In compliance with The Federal Water Pollution Control Act of 1972 (Public Law 92-500) and amendments (Clean Water Act of 1977 Public Law 95-217), the State of California was designated as the lead agency in formulating a continuing planning process for development of water-quality management plans and the implementation of programs pursuant to Section 208 of the Clean Water Act (here referred to simply as "208"). The State was further granted the authority to delegate responsibility to other State, Federal, local or interstate agencies for any portion of the required planning and for carrying out the provisions of the plans. Pursuant to Section 313 of the Act and Executive Order 12088, Federal agencies are required to comply with State and local requirements and to cooperate with State and local agencies in the prevention, control and abatement of environ mental pollution. As such, the California State Office of the Bureau of Land Management (BLM) entered into Standard Agreement #7-043-41, with the State Water Resources Control Board to assist in developing the State Water Quality Management Plan, pursuant to Part 131, Code of Federal Regulations 461-4, Subchapter D.

A team of six BLM hydrologists were assigned to the project. The parts of the agreement fulfilled in this document include:

(1) Identification of existing and potential water quality problems, including specific descriptions of their scope, magnitude, source, location, duration and any effects on current beneficial uses.

(2) Evaluation of current management practices related to water-quality control being applied to grazing and recreation activities; and identification of those practices which are not achieving water-quality goals.

(3) A program for the development of best management practices (BMPs), including an identification of limitations (fiscal constraints, institutional conflicts, economic impacts etc.) and need for additional regulatory authority.

(4) Recommendation of actions for the implementation of BMPs.

All of BLM's management activities which might impact water quality are discussed in the report to provide the reader with a general perspective However, particular attention is given to the Bureau's recreation and grazing management activities to fulfill Item (2), above, and to complement Items (3) and (4). The differences in these discussions are most evident in Chapter III.

Part I of this report, "Problem Assessment", includes as thorough a discussion of the problems as possible within the constraints of existing data. Discussions of current BLM practices and policies, potential for impacts on water quality as a result of these activities, and beneficial uses of water on BLM lands precede the section on identified problems. The primary purpose of the discussion of problem assessment is to identify non-point sources of water pollution originating on lands administered by the BLM. This section brings priority problem areas to the immediate attention of District Office resource managers.

Part II, "Best Management Practices", is primarily concerned with the development of a methodology to be used to formulate BMPs in future recommendations.

A reference-manual approach was used since the document will be used by various public agencies and staffs and by private individuals. Because all sections of the report are not pertinent to all readers, each chapter or section is internally cohesive. Where necessary, references to other chapters or to appendices are included. Even though the reference-manual format was used, the objective of "meeting the State water quality goals on BLM lands in the most practical and effective manner" is reflected throughout. Development, implementation, and evaluation of BMPs are important parts of the BLM statewide water-quality management program--they represent the means of achieving the objectives of the BLM, State Water Resources Control Board, and Federal legislation.

Development of BMPs and evaluation of their adequacy for controlling and/or reducing water position from non-point sources will be conducted on a site-specific basis by BLM District staff in the future. It is anticipated that site-specific implementation of a chosen BMP may not sufficiently protect or enhance water quality in all cases. Where this is the case, standards may have to be modified to reflect what is reasonably achievable in terms of beneficial uses. Furthermore, additional study of the site-specific field conditions will serve to identify natural background water-quality levels against which future comparisons can be made.

The completion of the project marks the initiation of a coordinated water-quality management effort by the BLM in California, and one which will assist in future land use decisions. The following discussion briefly summarizes the decision making process used by our agency.

Decision-Making Process

The Bureau of Land Management (BLM) has been preparing Resource Management Plans, called Management Framework Plans (MFP) since 1969. About 80 percent of the public lands administered by BLM outside of Alaska are covered under MFPs. New MFPs are being revised or supplemented under very tight schedules to guide decisions for the range, timber, and other resource management programs and to provide the proposed actions for related Environmental Impact Statements (EIS). Under the BLM's planning system, no particular land or resource use is given preference. In the planning process, each use is given equal consideration within constraints of policy social-economic factors, environmental protection as well as public comment and suggestions. During the planning process, areas may be identified as particularly valuable for water production and quality, livestock grazing, mining, timber production, off-road vehicle use, wildlife, recreation, wild horse and burros, etc. Decisions made during the planning process describe the management objective for a specific area and allocate resources for particular uses.

Beginning in October of 1984 the planning process will be based on Resource Management Plans which are developed on a Resource Area

Administrative Unit basis. Resource Areas are the smallest Administrative Units within the BLM. During the transition there will be a gradual shift from previous planning units to Resource Management Area Plans.

The basic planning process involves several steps which result in resource or land use decisions. The process begins with a preplanning analysis which identifies issues, concerns and opportunities. During this process the public as well as other Federal State, and local agencies and organizations are consulted and input is solicited to insure that critical issues and concerns as well as opportunities are identified. This process also contains the necessary scoping to allow proper allocation of inventory capability in areas and resources identified as having required input to the decision making process. During this initial step the public participation plan for the entire planning process is also developed.

Inventory data and information are collected during the second phase of planning. This phase involves resource, environmental, social, economic and institutional data and information collection and/or assembly. Public consultation and input are involved throughout.

The third phase of the planning process involves the analysis of the management situation. The field office manager, normally the District Manager, determines the capability and suitability of the public land resources to meet social, economic and environmental needs defined earlier in the planning process. This determination takes into account; the types of resource use and protection authorized by the Federal Land Policy and Management Act and other relevant legislation; opportunities to meet goals and objectives as defined by the BLM State Director and public participation as well as coordination with other Federal, State and local government and Native American tribes; the estimated sustained levels of various goods, services and uses that may be attained under existing biological and physicial conditions; and specific requirements and constraints to achieve consistency with policies, plans, and programs of other Federal, State, and local governments and Native American Indian tribes.

The next phase is the development of alternative courses of action to be analyzed within the Environmental Impact Statement process. This involves a number of management, biological, economic and social mixes which could be implemented under earlier planning components developed prior to this phase.

A draft plan and draft EIS are consolidated and published and public review and comment solicited. At the time of publication a preferred alternative is noted.

Allocations of land and resource uses within the planning area are made based, in part, on public review of and comment on the draft plan and EIS.

Following the allocation decisions individual resource plans are prepared under the guidance of the management objectives outlined in the plan for actual on-the-ground implementation of management actions. During this phase the public is again called upon for input and cooperation.

PART I - PROBLEM ASSESSMENT

INTRODUCTION

The 208 water-quality problem assessment report identifies water-quality problems on lands administered by the Bureau of Land Management in California.

Non-point source water-pollution control is a new BLM program in California. Very little water quality data or information currently exist in BLM District Office files. This lack of data, along with an insufficient inventory of non-point source water-quality problem areas necessitated the development of an information-gathering methodology.

The approach developed for obtaining problem assessment information is qualitative and subjective in nature. Budget and project time constraints precluded the implementation of a site-specific field water-quality sampling program. Quantitative documentation of problem areas is provided only where water resources data were sufficiently detailed.

The problem assessment data collection phase consisted of an orientation to the 208 water quality program at each District Office. Staffs were asked to supply information on existing, suspected, and potential problem areas; each BLM Office supplied a qualitative inventory of water-quality problems according to the following classification:

(1) EXISTING PROBLEMS. Problems which have been documented or observed in the past by BLM personnel to the extent that actions have been taken to correct the problem or to develop strategies for future management and control. This category includes problem areas that have been monitored to assess cause and effect relationships between a water-pollution problem source and a beneficial water use. All instances where impairment of a BLM beneficial water use has been identified are included in this category.

(2) SUSPECTED PROBLEMS. Problems which are likely to be included in the "existing problem" category only after field review of monitoring data has been conducted. Suspected problems have not been documented in the past but warrant further study because associated land management practices suggest that a conflict may exist between a problem area and a beneficial use. Problems are listed in the "suspected" category because:

(a) Problem scope and magnitude are not sufficiently known at the present time to show cause and effect relation between a problem area and a beneficial use; and

(b) Existing water-quality information reveals that water-quality parameter concentrations are above natural background levels but are not affecting any known beneficial use.

(3) POTENTIAL PROBLEMS. Problems which may create conflicts between water quality and beneficial uses at some future date. The "potential problem" category is highly subjective and is primarily based on the premise that certain land uses and land management strategies often create water-

pollution problems. Land management activities scheduled to take place at some future date are included in this category if water-quality problems are commonly associated with their implementation (e.g., timber harvest).

Follow-up meetings with each District Office, after initial problem assessment information was received, clarified and expanded on the information supplied by the District staff.

A number of State and Federal agencies involved with water resources management were contacted during the data-gathering phase of the problem assessment. Problem area identification input was received from the U.S. Forest Service, Soil Conservation Service and the State of California Regional Water Quality Control Boards.

A public participation program was also developed to solicit public input -- a newsletter and request for information were mailed to over 600 individual local units of government and special-interest groups. Input received was incorporated into the problem assessment.

Even with these efforts to identify water-quality problems on BLM lands, it is felt that the list is not complete. It is anticipated that future inventories conducted as part of the BLMplanning process will reveal additional problem areas.

The problem area analysis is designed to complement existing State of California Water Quality Control Plans. Problem area descriptions are grouped according to BLM District boundaries and hydrologic basins delineated in State Water Quality Control Plans. Sub-basins which were further subdivided or combined for clarity's sake referred to as "hydrologic areas" in this text.

Problem areas located within a hydrologic area are described according to the land management activity responsible for the water-quality problem. Each problem area is analyzed with respect to the BLM beneficial uses which are being impaired. Additional field data required to complete a detailed water-quality interpretation are included for each problem area.

Chapter 1

BLM MANAGEMENT ACTIVITIES RELATED TO WATER QUALITY

Many of the BLM's management activities can result in the introduction of substances into waters, in some cases, to the extent that pollution occurs. Potential impacts of these activities on water quality are also discussed below.

The water-quality problems identified for each hydrologic area (see Chapter 3) are grouped according to the type of land management activity category thought to be causing the problem. These management activities cover a broad spectrum and include:

Grazing	Recreation	Wildlife
Wild Horses and Burros	Silviculture	Low Volume Roads
Minerals	Fire	Waste Disposal Sites

A brief description of each category is presented to clarify the relationship between a water-quality problem and a management activity and to clarify terminology used in the problem assessment.

DESCRIPTION OF MANAGEMENT ACTIVITIES

Grazing

Of the 16.5 million acres of public lands managed by BLM in California, approximately 10 million are grazing lands. The three major types or rangelands managed for grazing are Great Basin Desert Arid and Mediterranean Annual. The majority of grazing lands in southern California consist of the Desert Arid type. The Great Basin type is principally found in the northeastern portion of the State. The majority of Desert Arid rangelands are contained within the California Desert Conservation Area and consist of large blocks of contiguous public land.

Great Basin rangeland is principally located in the northern portion of the State where precipitation is greater and temperatures are cooler. The primary differences between the Desert Arid and Great Basin vegetative rangelands are the predominant vegetative types and their relative abundance. Great Basin rangeland is normally associated with higher elevations.

The majority of rangelands located in the coastal regions of the State and in the foothills of the Sierra Nevada Mountains consist of the Mediterranean Annual type. This range type is found in central mountain areas with the public lands occurring in broken and highly dissected pattern of ownership.

The Mediterranean range type has the capacity to produce large volumes of forage each season, depending on climatic factors. This type is very important economically in terms of short term forage production.

Livestock grazing in California includes horses, goats, cattle and sheep. Additional demands are placed on forage by wildlife, wild horses and burros. Livestock grazing is controlled under an established range management procedure. Until there is a direct relationship between wildlife habitat condition and livestock use on the land where range management is administered within the State. With the passage of the Wild, Free Roaming Horse and Burro Act, the BLM began intensive management of wild horses and burros within the State.

The BLM purpose is to manage the public lands on the basis of multiple-use and sustained yield. The BLM range management program is keyed towards improving vegetative cover and forage production, and to protect basic soil and water resources essential to multiple use land management. The range management program directs grazing practices and vegetative resource analysis within the BLM.

The Taylor Grazing Act of 1934, the Federal Land Policy and Management Act (FLPMA) of 1976 and the Rangelands Improvement Act of 1978 (RIA) are the BLM's authority in managing grazing on public lands. These acts and subsequent supportive legislation outline the mechanisms to permit or lease livestock grazing. The RIA and FLPMA set forth procedures to determine fees for grazing permits or leases. The BLM directives system sets the methodology methodology for rangelands management and policy.

The BLM range management program is based on the allocation of forage and perpetuation of desirable vegetation. The emphasis in California BLM is to improve rangeland condition through equitable forage allocation and development of specific livestock grazing systems. The grazing allotment is the basic range management unit for which grazing systems and site specific planning are developed. The grazing allotments were derived through the adjudication process after the passage of the Taylor Grazing Act. Originally these allotments were one pasture delineations. They have been divided into pastures as a result of applying intensive management to the allotments. The allotment management plan (AMP) is the mechanism for setting up management systems and implementing on the ground projects for proper or intensive range mangement and resource protection. Overall management direction and guidelines for multiple use resource mangement are provided in the BLM planning system Management Framework Plan (MFP). The MFP encompasses resource needs, constraints, and potentials evaluated with socio-economic inputs and public demands and interests to set land and multiple use management goals and objectives.

The AMP is a method to implement site specific range management incorporating multiple use management considerations. Range management may vary from region to region and allotment to allotment, due to the variability of geographic locations, conditions, and configurations. The components of range management must be evaluated on a site specific basis. The objectives of the range management program are to insure proper utilization of the rangeland resources, while insuring that all other multiple use resource values are not destroyed, and to strive toward stabilization of the livestock industry.

AMP development embodies livestock management objectives as well as multiple use management objectives. AMPs may utilize the principles of intensive range management in planning and directing livestock grazing by employing various grazing systems that will maintain or improve plant communities for high level forage production for livestock forage, wildlife habitat, and watershed protection. AMPs are designed to provide protection and enhancement of rangeland resources consistent with long-term management objectives. Rangeland resources include forage, soil, watershed, recreation and aesthetic values, and wildlife habitat.

Vegetative inventories provide information to assess forage production, composition, cover, and condition of the rangeland. Grazing capacity and season are determined based on the vegetative inventory information of forage production, trend and condition. Grazing capacity is often expressed in the number of animal unit months (AUMs) available in an allotment. The AUM is the amount of forage necessary to support one cow and a calf, five sheep, or one horse for one month. The forage necessary to meet various multiple use objectives on public rangelands are computed into AUMs and the AUMs allocated to the various uses. Condition and trend within an allotment is determined through the establishment of site specific key forage species and are measured throughout the grazing cycle. From this data, utilization is determined and appropriate adjustments are made in livestock use to meet specific objectives which have been established in the AMPs.

The volume of key forage species to remain will vary depending on vegetation composition and management objectives. The remaining vegetation is for plant vigor, perpetuation of species and soil stability. The percentage of excess forage each use is allocated varies based on allotment management plans and its multiple use objectives. Season of use is based on plant community physiology and environmental constraints, such as soil moisture-runoff relationships or wildlife critical habitat requirements.

Distribution of grazing animals is influenced by water resources, water developments, topography, fencing, salting practices, animal preferences, and vegetative association. Evaluation of these aspects in each allotment is necessary to insure proper distribution.

The BLM regulates livestock operators with a system of licensing by permit or lease for grazing privileges. Permits for grazing are allowed under Section 3 of the Taylor Grazing Act; however most of California BLM grazing is authorized by lease under Section 15. The principal difference between these two management systems is the manner in which grazing rights and privileges are tied to private land ownership. A brief description of the grazing management systems listed above follows.

Section 3 licensed grazing lands are synonymous with grazing district lands established by the BLM under the Federal Range Code for Grazing Districts. Section 3 lands primarily occur in the Susanville and Bakersfield Districts where the BLM administers large tracts of public land. Section 3 grazing permits are renewed every few years. Grazing operators who hold Section 3 grazing permits must own preference lands which are capable of supporting their livestock operations for a portion of the year when public grazing lands are closed to livestock use. Additionally, an applicant who desires a Section 3 permit must be a bona fide livestock operator.

Historically, Section 3 grazing lands have been managed more intensively in comparison to Section 15 lands. The Section 3 grazing program was originally established pursuant to the objective in the preamable of the Taylor Grazing Act which strives to assure stability in the western livestock industry. Section 3 lands constitute less than half of the 10 million acres of grazing land in California but support the majority of livestock grazed on BLM administered lands.

Section 15 leased grazing land makes up the majority of BLM grazing lands in the State of California. Section 15 lands are scattered throughout all the BLM Districts in California. A large majority of BLM Section 15 lands is interspersed between other land holdings in the form of small tracts. An applicant can obtain a Section 15 grazing lease if he is a bona fide livestock operator and owns contiguous private lands. A grazing lease may be obtained by an operator who does not own contiguous lands if the land owner with an unexercised preference grazing right concurs.

The total productivity of Section 15 rangelands, in terms of livestock numbers supported, is less than the productivity on Section 3 rangeland even though Section 15 land makes up the majority of all BLM grazing land in California.

The lease or permit renewal period for both Section 3 and 15 is 10 years with the passage of FLPMA and RIA.

Revenue is collected by the BLM for grazing permits based on a fee per AUM. The Taylor Grazing Act of 1934 and FLPMA set the procedure for licensing of operators. FLPMA required a study of how to determine fees while the RIA set forth procedures to set fees. The AMP identifies specific restrictions to be incorporated into the permit for each allotment. Provided sufficient information exists from trend and utilization analysis, the number of AUMs can be altered from season to season or when grazing permittees are relicensed to reflect changes in forage production.

There are approximately 960 allotments for livestock within the State at the present time. Almost 4 percent of the allotments have recently completed AMPs. The Natural Resources Defense Council (NRDC) vs Andrus court settlement called for the BLM to write environmental statements (ES) on its range management program. In most cases ESs, as well as AMPs, are required before on-the-ground range improvements can be made. The exception can be made when range improvements are necessary to stop range degradation and will not affect or damage the environment. Completion of the livestock grazing ESs scheduled in 1984 in California, and writing of AMPs for these areas may carry over an additional one to three years. On-the-ground implementation may take longer depending on funding and manpower allocations. Few on-the-ground range improvements will be initiated until the livestock grazing ESs are completed.

The emphasis of the BLM range program in California at present budget and manpower levels is on range survey, environmental statements and, in connection with the NRDC settlement, AMP development as well as managing the present grazing program on public lands. Beginning in 1979 an accelerated range project implementation program will occur on those areas where a completed ES and AMP has been accomplished.

Constraints

The constraints placed on the BLM range management program are linked directly to manpower and budget levels. Only recently have the California Districts had multiple discipline resource expertise. The addition of water resource management and soils staff to the District Offices will provide needed assistance and coordination with the range and wildlife specialists in preparation of AMP and range management guides. The BLM planning efforts in the past have not had strong water resource and soils sections and therefore have been weak in watershed and water resource management objectives and goals. This deficiency was recognized and has been corrected.

The commitment of the existing range specialists and support staff to the completion of NRDC settlement ESs has taken away from other range improvement programs. The completion of the range ESs and accompanying AMPs will insure updating of vegetative inventories and AMPs. More comprehensive range management and a commitment for future range improvement projects will be the overall results of the NRDC settlement.

Manpower levels in the range program and budget allocation for range supervision have severely limited range management on public lands. Often, trend and utilization analysis cannot be completed as often as needed because of limitations in personnel Checks of actual on-the-ground livestock operations to insure that the permitted number of livestock are utilizing the range and that the designated grazing system and seasonal constraints are being complied with is not adequately carried out because of insufficient funding for range supervision. The suspected trespass of livestock and improper compliance with range management restrictions are several of the reasons for over-utilization of forage and range degradation in some areas. Often, over grazing occurs because of over-utilization of the grazing permit.

Maintenance of existing range improvements is limited because of budget constraints and lack of supervision to identify maintenance needs. Based on FLPMA, 50 percent of the grazing fees collected on public lands are returned to BLM for maintenance and installation of range improvements. Of this, one half or 25 percent of the total fees must be returned to the District from which they wre derived.

Recreation

The Bureau of Land Management, like other Federal resource agencies, provides recreation resource opportunities and protection of those resources for a multitude of uses. Nearly every outdoor recreation use is pursued on the 16 million plus acres of public lands within California. Many recreation activities depend on water or are influenced by water resources. Water resources of an area attract various recreation activities to that area. This attraction tends to concentrate recreation use in and around surface water.

Recreation will be discussed in two segments: Recreation Activities and Recreation Management Programs.

Camping is a major recreational activity and occurs in association with various other activities. Camping can occur in designated camp facilities or on the open public lands. Everything from large recreational vehicles to throw down tent and bedroll camping occurs on public lands. The length of stay varies greatly for the type of camping experience desired by the user. Designated campgrounds with sewage, water, showers, tables, and paved roads are probably the most intensive form of camping in terms of facilities and cost to accommodate the opportunity.

Picnicking is very similar to camping, but is a day use activity. Facilities required also vary greatly depending on the type of experience desired by the user. The majority of picnicking occurs in conjunction with other recreational activities. Picnicking on public lands occurs predominately in unstructured forms utilizing no facilities or designated areas. However, water is a major attraction.

The use of off-road vehicles (ORV) has become very popular as a recreational activity in California, especially in the desert areas of the State. The sparse, flat desert lands are ideally suited for ORV use. The mild winter climate of the desert attracts most of the users in the winter season.

ORV use generally involves the operation of various types of vehicles (e.g., four-wheel-drive trucks or buggies, and motorcycles) on the roads and open areas of the public lands. The use of ORVs varies from organized events involving large numbers of vehicles and people to individual family outings. Often other recreational uses of public lands occur in conjunction with ORV use such as camping, picnicking, rockhounding, and sightseeing. Competitive racing of ORVs is a major form of organized ORV use. These events require permits from the BLM to help provide proper management in order to protect rescouces or to mitigate or minimize any environmental impacts associated with the event.

Float-boating is the term given to the recreation activity which involves floating in kayaks, canoes, and inflatable rafts or boats utilizing the current of the river for propulsion. The majority of float-boating the BLM becomes involved with occurs on white water rivers. Float-boating is done by groups or by individuals, depending on the type of boat. White water floating is becoming very popular on many rivers throughout the State.

Companies offer trips down various white water rivers in California. These trips usually are groups on inflatable rafts and often are overnight trips with the groups camping along the river. Many of the daylong float trips have associated camping by the river users at the launch and take out areas or areas adjacent to these points. Rafters generally account for the largest group of users on the rivers. The commercial trips are generally fairly well controlled and can be managed as to numbers of users, camp areas, and camping techniques.

Private users are more difficult to regulate. Their use is fairly scattered and indiscriminate in terms of numbers and camping in conjunction with the float trips.

Boating and swimming occur on many lakes and rivers with public lands adjacent to these water resources. Public lands sometimes are utilized for access to these water resources for boating and swimming. Boating can include power boats, row boats and sailboats and are used for a variety of recreational pasttimes such as water skiing, fishing, racing, camping, and relaxation.

Fishing and hunting are activities which occur on public lands throughout California. These recreational uses are unstructured type activities and generally are uncontrolled by recreation management on public lands. Hiking, picnicking, and camping are often activities associated with hunting and fishing. Public demand for hunting and fishing is quite high since public lands are open for public access.

Recreation Management Programs

The Bureau participates in recreation programs of national scope, including wild and scenic rivers, trails, antiquities, natural and historical landmarks, and national conservation areas.

Throughout the State, BLM manages 37 existing campground facilities and has constructed and is operating BLM's first major visitor contact and interpretive center, the Barstow Visitor Center, located in the California Desert.

Major construction has been completed on 32 miles of the Pacific Crest Trail in Southern California. Progress is underway for the construction and management of 113 additional miles. Involvement is also underway in the National Wild, Scenic and Recreational Rivers program. Over the next 15 months, BLM will be working closely with the State of California in the development of the State's Cooperative Outdoor Recreation Plan. BLM is also studying the public lands in California for wilderness values and providing interim management guidance.

It has been the Bureau's management objective to provide a quality recreation experience through proper resource and facility management. User groups and "existing use" have for many years dictated the management direction for recreational opportunities and facility development on public land. The BLM utilizes three methods of management to regulate use: education of users and interpretation of the environmental processes; direction of recreational use by regulation, signs and informational brochures; and control through physical constraints and Ranger patrols in the California Desert. The Bureau recognizes the need for proper recreation management planning which is provided for by the Resource Management Plan (RMP) process which provides goals and objectives for recreation and sets policy for recreation management within each of the six districts. The basis for BLM's intensive recreation management is the Recreation Activity Plan (RAP). These plans establish how the various guidelines, management objectives, and planning decisions in the RMP are to be carried out. They are much more detailed and identify specific actions to be taken on specific sites. Most recreational use for which these plans try to manage can best be described as dispersed or unstructured since most public land is open to the public for all forms of recreational use, provided it does not destroy or adversely impact the long term values of the land. Some areas of public

land have restricted use or specific restrictions placed on them as to the type of recreational use which may occur because of a fragile ecosystem or potential irreversible impacts which might occur. Most of these types of impacts are regulated by the BLM's, Special Use Permit system, developed specifically to handle organized recreational events such as off-road vehicle races and club outings.

It has been estimated that the public lands received 16 million visitor use days (VUD) in 1977 with an estimated 12 million VUDs in the California Desert Conservation Area. At present the BLM has recreational facilities and programs to handle only 7-8 percent of this use.

Specific recreation programs include the following:

Cultural Resources -- California is unique in the diversity, magnitude and antiquity of its cultural, historical and paleontological resources. It has been estimated that a cultural resource site will be found on every 100 acres of BLM land in California, and one out of every 3 sites found will be of National Register significance. BLM must locate and provide for the management and protection of these cultural values as part of every planning decision and resource use authorized. In addition, the State of California now has a Native American Heritage Commission and is actively pursuing the protection of all cultural values held by living Native Americans including sacred and ceremonial sites, many of which are on the public lands.

King Range National Conservation Area -- The King Range National Conservation Area which comprises 60,000 acres of timbered mountains, grassy hills, and rugged coastline in northern California was authorized by passage of the "King Range Act" on October 21, 1970. The area was designated the Nation's first National Conservation Area in October 1974 upon completion of a management plan and an environmental statement by BLM.

Pacific Crest Trail -- The 2,350-mile Pacific Crest Trail between the Mexican and the Canadian borders, through California, Oregon and Washington, was established by the National Trails System Act. Approximately 145 miles of the trail route on both public and private land is under the management responsibility of BLM in California.

Recreation Land Acquisition -- The BLM in California is establishing a pilot program for FY-79-81 to exercise the Federal Land Policy and Management Act authority for utilization of Land and Water Conservation Fund Act (L&WCF) monies for land acquisition, thus giving BLM the opportunity to tap a $966 million fund for land acquisition. BLM's current funding level is $3.3 million for FY-78, and $5.5 million for FY-79.

White Water Management -- The popularity of white water and related uses and its growth in recent years has placed significant pressures on BLM to manage this program. Nine rivers are receiving moderate to heavy white water use, and 11 rivers offer such potential. On the Stanislaus River in 1975, 25,000 people floated the river commercially and 11,000 used the river in a non-commercial status. Commercial rafting companies grossed $650,000 on the Stanislaus River alone in 1975. Because 1976 and 1977 were drought years they were not typical of normal river use.

Off-Road Vehicles -- There are over 1.5 million off-road vehicles within the State of California. The 14,000 miles of vehicle routes and the 13 "open" areas located on the public lands are significant use areas for these vehicles. About 150 competitive vehicle events are scheduled each year on the public lands involving some 60,000 participants and 200,000 spectators. The Bureau collects about $60,000 from authorized competitive events each year.

Wilderness -- Wilderness is a major environmental issue in California. Although BLM wilderness procedures are not yet final, the wilderness issue is already having an impact on many areas, including energy development, mining, range, forestry and ORV programs. Wilderness inventory on BLM land is approved on two projects in California: the Sundesert Nuclear Power Plant, and the California Desert Plan.

Law Enforcement -- Greatly increased use of public lands for recreation within the last 20 years has been accompanied by a dramatic rise in the occurrence of crime: those crimes which users commit against each other and those crimes which involve theft and destruction of resources. The most prevalent crimes against resources are theft, destruction, range arson and illegal occupancy.

Constraints

The BLM recreation program has increased and expanded along with the increase in use, especially in the last two years. Unfortunately use and demand by the public for recreation opportunities has overtaken the BLM's ability to provide the best recreation management by our District personnel. Even with the accomplishments in recreation resource inventory, the recreation management component of the program has not been able to develop at the same rate as other recreation components of the recreation program or other resource programs of national significance. The BLM does provide ample recreation management in many areas and has the potential within the program to provide all the management direction needed for proper recreation management in the future. The major emphasis for work and funding of the California BLM's recreation program has been toward the other components of the program. Other mandted programs have affected the time and emphasis placed on recreation management. Present program structure and emphasis are not providing sufficient recreation management to protect or mitigate all the impacts occuring from recreation use on public lands. The recreation program has the potential to provide necessary recreation management but shifts may be required in the recreation program emphasis or funding and personnel commitments, in order to provide more recreation management (i.e., education, interpretation, facilities, and directin) for a larger percentage of the uses.

Wildlife

The BLM is responsible for providing and maintaining suitable habitat for the support of wildlife on all public lands in California. Wildlife habitat on these lands is extremely diverse because of the extreme variations of major vegetation associations and biomes. Wildlife in this report will include big game andimals, non-game animals, birds, raptors, and fish. The wildlife program is set up to protect, maintain, and enhance a natural diversity of wildlife and wildlife habitat.

Present emphasis is on inventories of wildlife and wildlife habitat for input into the ESs and environmental analyses conducted for energy, grazing and timber harvest programs as well as for development of the wildlife portions of the BLM planning system. Input into these analyses is to insure that wildlife and wildlife habitat are protected and maintained and will not be impacted by the other programs.

The other major component of the wildlife and wildlife habitat program is development, protection and enhancement of the wildlife habitat strictly for wildlife's sake. Habitat management plans (HMP) are activity plans developed for protection or enhancement of wildlife habitat for a specific species or ecosystem. HMPs are developed based on guidelines set by the MFP and involve input from various resource aspects. In some areas, special provisions are made for the protection of wildlife habitat through the designation of game ranges or wildlife refuges.

Wild Horses and Burros

Wild, free-roaming horses and burros are found in various regions of the State on public lands, primarily in the Susanville, Bakersfield, and Riverside Districts. The Wild, Free-Roaming Horse and Burro Act of 1971 provides protection of these animals. They are protected from unauthorized capture, branding, and destruction. The BLM is required to manage their habitat in such a manner as to assure ecological balance and a thriving population of sound, healthy individuals. The BLM determines the optimum number of animals to be maintained in an area and then reserves adequate forage to satisfy their requirements. Adjustments may be made in livestock numbers if a conflict arises. Livestock may be entirely excluded from ranges allocated to wild horse and burros if it is necessary.

At the present time, there are approximately 3,800 wild horses and 6,500 wild burros on public lands in California. Planned levels for California are 1,600 horses and 670 burros, based on interim management guidelines. Upon completion of updated MFPs, in conjunction with the livestock grazing ESs, goals and guidelines will be set for population levels of wild horses and burros, which may vary from the above numbers slightly.

The BLM may roundup and remove wild horses and burros from public lands and dispose of the animals though the "Adopt-a-Horse Program." This program allows us to give horses or burros to people who desire them and have adequate land or facilities to support the animals.

Silviculture

The BLM manages approximately 240,000 acres of commercial timber land and over 600,000 acres of non-commercial timber and woodland in three sustained yield units. The four northern Districts contain the majority of the 3.5 billion board feet of BLM's commercial timber with an annual sustained yield allowable cut of 2.5 million board feet. The management objectives are to develop and market the full productive capability of the commerical timber lands under multiple use and sustained yield principles, based on the allocation of forest lands to timber production under the Bureau's planning system. This planning system requires the development of an Allowable Cut Plan

which includes commitments of all silviculture measures necessary to maintain a sustained yield of commercial quality timber. Usually such measures as reforestation, rehabilitation, precommercial thinning and commercial thinning would be addressed. However, the methods of performing each of these tasks are not specified in the Allowable Cut Plan. This allows the most appropriate treatment for each site application. As such the use of mechanical, chemical, or prescribed burning may be applied at any site as determined to be the best treatment for that site. As a matter of policy, the California BLM does not apply chemicals to a forest site by areal application. Among other values, this would insure that only target organisms are hit.

The silviculture methods used in the State may include all those methods which are considered appropriate to insure the sustained yield goal without having an adverse impact on other resources. As an example it is policy that the method of harvest does not move significant amounts of earth material thereby minimizing the potential for accelerated erosion. In some areas this will preclude the use of tractors; in a few unique instances helicopters have been used.

For the purposes of this report, "silviculture" refers only to those activities which directly provide for the growth and management of a forest. Support activities, such as road construction, are addressed elsewhere.

Low Volume Roads

The BLM is involved in road and building construction both directly and indirectly. (Currently the BLM includes about 2500 miles of roads in its road network of which about 450 miles are funded for annual maintenance.) Many roads are authorized for construction in order to gain access to timber, minerals, grazing land and recreation areas. Rights-of-way are also granted for a number of purposes and often involve the construction of roads and structures.

Roads may best be considered for water quality purposes by classification according to season of use and type of maintenance. Roads that have been identified in the problem assessment include the following low volume types.

Permanent Roads -- Roads that are designed and maintained for year round traffic. Permanent roads are suited only for the types of vehicles for which they are designed and may be surfaced. Culverts, bridges, and other design features are constructed to function under a wide range of environmental conditions. Routine maintenance is required.

Seasonal Roads -- Roads that are designed and maintained for recurring use during the dry season only. Seasonal roads are maintained on a regular basis, usually twice a year. These roads must be winterized or put to bed during the wet months of the year. Culverts and other road design features are designed to function properly during the season of use. Provisions must be made for removal of culverts before the wet season begins if failures are expected. Seasonal roads are opened on a yearly basis in the spring after the wet season is past. Maintenance of seasonal roads is intensive and expensive if done properly. Seasonal roads may be surfaced, depending upon the type of traffic carried.

Temporary Roads -- Roads that are designed and maintained for temporary use on a one time basis. Usually, temporary roads are designed for a single purpose such as timber harvest and are subsequently closed upon suspension of operations. Such spur type of roads are usually associated with more permanent roads. Temporary roads are designed for use during favorable conditions only, and may be closed prematurely if conditions arise that accelerate deterioration.

Temporary roads do not make use of all-weather design practices, especially as far as drainage and hydraulics are concerned. Temporary roads are usually put to bed by a specified date to assure non-failure.

Fire

The Bureau considers fire to be a two-edged sword. As a management tool it provides indispensible good. In specific range application, fire management accomplishes vegetation manipulation projects in a fashion which has much more acceptable results than any other method. For example, compared to mechanical methods, fire does not disturb cultural resources. Fire can also be instrumental in increasing desirable fire sprouting forage species, and have less of an impact on the soil properties involved in the erosion process. In silvicultural operations fire has been used to accomplish a reduction in fuel loading and to expose a seed bed. However, the primary use involves the reduction of undesirable vegetation.

As a detrimental force, wildfire or poorly controlled prescribed burning has required emergency suppression measures. Consequently, fire prevention and presuppression measures have been incorporated in BLM's management. These measures include maintenance of roads for fire control access and construction of fire breaks. Wildfires are not always suppressed by the BLM; it depends upon the values involved. For example in wilderness areas there is a "let-burn" policy except for certain seasons when it is too dangerous to let a fire burn out of control.

Waste Disposal Sites

The BLM may lease land for waste disposal under the Recreation and Public Purposes Act (R&PP) of 1976. The procedures which the BLM follows in granting a waste disposal lease are found in 43 CFR 2912.3, "Leases for Solid Waste Disposal Sites." Included in this section are provisions of other applicable statutes regarding the safe disposal of solid waste materials. Old leases and plans of development already in existence and lacking these specific stipulations will be amended to require compliance with the above guidelines by lessees. In all cases the leases must stipulate that failure to comply with the guidelines shall constitute sufficient grounds for cancellation of the lease.

The problem assessment identifies solid waste disposal sites which are known to be contributors to water pollution by virtue of the hydrologic characteristics of their locations.

Oil disposal is a potential problem in some areas. The problem assessment also addresses oil disposal, both intentional and accidental, as a separate problem category.

Details on the BLM solid waste disposal and oil disposal programs can be found by referring to the BLM Solid Waste Disposal Plan and the BLM Oil Spill Contingency Plan. These plans are a product of the BLM's 208 study.

Minerals

The minerals program includes disposing of minerals by lease, license and permit; coordinating exploration and mining activities with other land uses; and providing protection and rehabilitation of mined land. The program also involves adjudicating mineral patent applications, economic analyses and appraisals.

The objective of the minerals program is to make lands available for mineral exploration and development to contribute to the Nation's becoming more energy self-sufficient by 1985; minimize impacts on other resouces; protect other resources (including water) with overriding values and require adequate rehabilitation.

Minerals on the public lands are categorized as locatable, leasable, and salable.

Locatable -- Those minerals that may be staked and claimed under the General Mining Law of 1872: gold, silver, lead, copper, zinc and uranium.

Leasable -- Minerals subject to leasing under the Minerals Leasing Act of 1920 and other authorities, including oil and gas, coal, oil shale, phosphate, sodium, potassium and geothermal resources.

Salable -- Materials sold under the Materials Sale Act of 1947, including common varieties of stone, scoria, sand and gravel.

A mining claim may be patented or unpatented. A patented mining claim is one for which the Federal Government has given a deed or passed its title to the claimant. A valid unpatented mining claim is one for which the claimant has obtained the right to extract and remove minerals from the land due to the discovery of a valuable mineral desposit under the mining laws, but to which the claimant has not acquired full title. Either mining claim requires a discovery of a valuable mineral deposit such as satisfies the "prudent man or marketability" test.

It is not necessary to have a patent to mine and remove minerals from a valid mining claim, but a patent will give one exclusive title to the locatable minerals and, in most cases, to use of the surface and all other resources. Since the claimant does not hold full title to an unpatented mining claim, the Government may, at any time, question or challenge its validity. If the Government's challenge is successful, the claim will be cancelled and all rights to the claim will be forfeited.

POTENTIAL IMPACTS OF MANAGEMENT ACTIVITIES ON WATER RESOURCES

Beneficial water uses are impacted or affected by land management activities that lead to modifications of the natural physical/chemical system. The Bureau of Land Management permits or engages in many activities which have the potential to degrade water quality and impair beneficial uses. Land management activity categories utilized to classify water quality problems on Bureau administered lands are addressed in terms of their potential for water quality degradation. Most land uses affect water quality directly through activities on, in, or near the water resource in question. Other land use activities have more subtle effects on water quality which may not be readily identifiable. A discussion of major BLM activity categories and their potential effects on water quality follows.

For convenience, a summary of water quality constituents that relate to specific management activities, and the effects of each constituent on water resources, are given in Appendix A.

Grazing

Impacts on rangeland and water resources are caused by three aspects of livestock grazing: the physical presence of grazing animals; the use of vegetative cover; and physical management structures. The following discussion addresses these three impacts.

The presence of livestock has impacts on the range by causing compaction and physically destroying soil structure. Animal concentrations at wet meadows, water sources, along fence lines, and at mineral blocks, are areas where trampling can occur resulting in compaction. Compaction impacts infiltration and increases runoff which aggravates gully and rill erosion.

Livestock often cave in streambanks and slopes adjacent to streams, and often walk in the streams stirring bottom sediment.

Livestock will concentrate in and around water sources resulting in introduction of fecal material into the water. Many organisms such as fungi, algae, viruses, protozoa, and a wide array of bacteria are induced from the fecal material. Fecal coliform and fecal streptococci counts are used to indicate the presence of fecal pollution in the water. Seasonal temperature increases coupled with fecal deposition, add nutrients into the stream which allows organisms to multiply. Increases in phosphates and nitrates aid the growth of a bluegreen algae which tie up dissolved oxygen. It is not uncommon for livestock to die and drop in water sources. Bacterial and biological pollution results tying up oxygen because of increased BOD.

Excessive or poorly distributed livestock will have an impact on riparian vegetation quite often. Trampling and consumption of the riparian vegetation allow for temperature increases of the water resources and create streambank instability.

The use of the vegetative cover by livestock has significant impact on water quality when livestock are poorly managed. Overgrazing and improper distribution are the major factors in excessive removal of vegetative cover by

livestock. Loss of vegetative cover reduces vegetative litter, "roughness" of the surface, and detention of surface moisture. These factors reduce infiltration and increase surface runoff which promotes soil erosion. Grazing of revegetated areas too soon allows immature plants to be removed and no cover is able to establish and protect the area from erosion. Loss of vegetative cover enables frost heaving phenomena to occur which detaches the surface soil. The vegetative root complex is critical for slope stability and erosion prevention. Over-utilization of the vegetative cover is detrimental to plant vigor, seed production, litter production, and root growth.

The physical management structures needed for management of livestock grazing, if improperly developed, often create water quality problems from erosion and vegetative cover loss. Construction of stock water reservoires, range access roads, and stock trails, can produce abnormal amounts of sediment from exposed soils and poor drainage. Destruction of the residual vegetative cover from construction of these facilities will promote eroson from disturbed soils or the unprotected construction site. Improper location of fences with respect to topography will create livestock trails along cleared fence lines resulting in gullies forming. Fencing across streams and drainages or improperly constructed "water gaps" can create debris dams and alter stream flow causing downstream channel erosion and flooding. Placement of water wells, water tanks, and mineral blocks in critical or erosive soil areas is detrimental to the vegetative cover because of excessive trampling and animal concentration. Placement of holding pens and load-out chutes often occurs adjacent to water sources which can cause significant fecal bacterial pollution. Improperly constructed water developments which protect against syphon action, often allow pollutants to contaminate the water source.

Spraying projects for range pest control or vegetation manipulation often is done improperly letting pesticides or herbicides enter streams and water sources directly. Aerial spraying projects are the major causes of these types of impacts.

The magnitude of impact that livestock have on the rangeland and associated water resources can be lessened or mitigated with implementaton of various range management techniques or grazing systems. The major impact from livestock grazing on water quality is attributable to erosion.

Recreation

Recreational activities have the potential to affect water qualty in a wide variety of aspects. The broad spectrum of recreational uses occurring on public lands in California accounts for this. The predominate cause of most recreational use impacts on water quality are over utilization, or concentration of users in a specific area. Recreation activities often occur or are associated with water resources; the water attracts recreational use to the area and often recreation use involves the water resource. The major water quality parameters most often affected by recreation are sediment, turbidity, and bacteria.

The impacts associated with camping vary greatly with the type. Continued camping in areas with poor soil structure or on frail watershed areas can result in compaction or loss of vegetative cover. Increased runoff and

erosion generally occur from these impacts. Sewage treatment and disposal are critical with respect to water quality. Improper placement and operation of latrines will permit sewage wastes to enter groundwater or surface water sources. The indiscriminate dumping of garbage and holding tank waste from dispersed camping can have an impact on water quality where these wastes contact the water resource. Picnicking affects water quality in the same manner as camping.

The use of off-road vehicles in an area results in disturbance of the soil surface. Shear stress of ORV tires on the soil surface breaks away the surface layer of soil, while the vehicle weight compacts lower soil layers. The detached surface layer is then susceptible to the erosive forces of wind and water. The compaction will decrease infiltration and subsequently can increase the runoff. In fragile ecosystems, the vegetative cover is easily destroyed or uprooted; this loss of vegetative cover increases runoff and erosion. ORV use often creates tracks which, because of their undesigned development, become gullied. ORV use in many of the desert areas is not a major impact on the water resources. Erosion in many of the desert areas does not enter live streams or affect water sources. In areas with steep slopes and in watersheds with important or critical water resources, ORV use can be detrimental to the water quality. In these areas any amount of erosion and sedimentation will have a significant impact on water quality. The water resources, soil characteristics, and topography generally dictate the magnitude of impact ORVs have on an area.

Float boating can significantly impact water quality when improper sanitary disposal practices occur. Sanitary waste disposal directly into rivers or on porous soils adjacent to the water course contributes fecal bacteria, viruses, protozoa, and other possible pathogens to the stream. Because the majority of float boating occurs when water temperatures are highest, bacterial constituents readily multiply and live longer. As the number of float boaters increases on a river, the potential for dangerous levels of bacterial pollution increases. Swimming and human contact with water occurs, with float boating allowing for coliform baceria to enter the water.

Boating can affect water quality in the same manner as float boating, but can be more severe. Generally, boating occurs in lakes and slower rivers where water temperatures are warmer and bacterial constituents multiply faster. The turnover or flushing action of these more sedentary water resources is slower, providing better habitat for bacterial constituents. Power boating contributes small amounts of oil and gas from the operation of boat engines. The constituents are minor in their affect on water quality, but during periods of heavy boating use, the cumulative discharge of oil and gas by boat engines can have a significant impact on the water quality.

Fishing, hunting, and hiking have an impact on water quality as a result of concentrations of use. Compaction of soils and gullying from trails and improper drainage accelerate erosion. Trails along streams and creeks are the major sources of this type of erosion. Destruction of riparian vegetation and bank sloughing from fishermen constantly utilizing areas, cause bank instability which increases erosion potential. The improper disposal of animal carcasses and entrails from hunting can also cause water quality impacts.

Wildlife

The impacts of wildlife on water quality are generally isolated and quite uncommon. Impacts of wildlife on water resources on rangeland are the same as livestock, but population control and decreasing habitat have minimized the problem of wildlife concentration and over utilization of vegetation, which are the major causes of livestock impacts. Wintering areas often have concentrations of wildlife as well as extreme weather conditions and can cause wildlife to concentrate resulting in trampling and overgrazing. Bacterial and fecal pollution of water sources is not as predominate from wildlife because of their watering habits, but elk, deer and buffalo can be quite detrimental to a water resource in terms of fecal pollution.

Wild Horses and Burros

Wild horses and burros have an impact on water quality on rangeland in the same manner as livestock as discussed in the previous section. These animals tend to concentrate around water sources more than livestock. Without population control of the wild horses and especially burros prime rangland and wildlife habitat will deteriorate rapidly. Wild horse movements can not be effectively controlled to the benefit of vegetative conditions, further complicating management, as these animals remain in the area year-round often depleting favored areas until deteriorated. Burros are especially detrimental to springs in the desert area because they tend to establish around the water sources and will often wallow and defecate in the water.

Silviculture

Silvicultural activities have an impact on water quality by increasing erosion and sedimentation. Clearcut timber harvest practices used on steep slopes and on shallow erodible soil types may increase erosion significantly. In some areas, silvicultural practices may directly lead to massive failures which can contribute large quantities of sediment to surface waters.

Vegetation removal and surface disturbance within the riparian zone are two activities that have the greatest potential for degrading water quality in timber harvest areas. Stream water temperatures may increase drastically if shade producing cover is removed from the stream zone. Disturbance of the streambanks is particularly detrimental to water quality because of the resulting increase in channel erosion and sedimentation. Skid trails which are placed in the bottom of an ephemeral stream channel disturb the streambed materials which may be washed away during high flow periods.

Organic pollution resulting from slash entering surface waters may also occur. Elevated levels of biochemical oxygen demand are not uncommon when slash is deposited in stream channels. Debris dams are an important impact in spawning channels.

Low Volume Roads

Road drainage is probably the most important design consideration for the protection of water quality. Construction activities disturb the land

surface and expose previously protected soils to precipitation and other climatic conditions that accelerate erosional processes. The relocation of earthern materials, as occurs in side-casting, full construction and waste disposal, can lead to immediate or delayed sediment delivery to a stream channel through either gravitational or hydrologic processess. More directly construction practices compact the soil and increase runoff. Also stream channels may be altered or subsurface water may be intercepted. These latter three situations will lead to accelerated erosion on previously unchanneled surfaces or in existing channels if drainage control is not adequately incorporated.

Impacts on water quality that result from road and other construction activities may include those associated with increased turbidiy and sedimentation. The uses which in turn may be affected by increases in these two water quality constituents are most likely to include both contact and non-contact recreation, fisheries habitat, and drinking water supply. While not actually a beneficial use, stream hydrologics could also be affected and thereby have consequential impacts.

Fire

While fire dramatically affects the vegetation, soils, and hydrology of a site in many ways, this cursory discussion only addresses those which are related to water quality. The destruction of vegetation by fire often causes changes in the hydrologic properties of the watershed. Surface runoff, and consequently erosion, usually increases immediately after a fire due to a decrease in surface water retention and infiltration in combination with an increase in rainfall energy able to dislodge soil and induce movement. Since the magnitude of the impact is subject to other intensity of the burn, nature of the soil properties, and topography, seldom are two sites similar in response. Often the suppression and presuppression activities have a greater impact on water quality than the fire itself. In an emergency situation many trails and roads are constructed without the benefit of sound engineering principles and neglecting three of the four phases of good road construction practices. Seldom are there any design, maintenance, or abandonment activities associated with these constructions. As previously discussed, this could result in significant sediment delivery to nearby streams.

Another impact which is apparently just as ambiguous in predictability as sedimentation is that of nutrient delivery to the stream. Nutrient increases have been observed to occur following burns on experimental watersheds as a result of transport of clay particles which have nutrients bound to them. Delivery leaching is not currently considered to be significant.

Where a shade producing vegetative cover is removed by fire, a temperature increase of the surface waters would be expected.

Waste Disposal Sites

Solid waste disposal sites may impact water quality where waste material is hydraulically connected to the free groundwater surface. Many types of

pollutants can enter the groundwater in the form of leachate produced from the waste material. Polluted groundwater may subsequently enter surface waters and degrade stream water quality.

Surface waters may also be affected by waste disposal activities. Sanitary landfilling procedures require the movement of large amounts of unprotected soil which may enter surface streams. Modification of soil permeability and surface topography increases surface runoff which carries with it elevated concentrations of dissolved and suspended solids.

Oil may degrade water quality if disposal is in close proximity to surface waters. Pollution from oil spills and disposal usually results from the movement and deposition of contaminated soil particles in surface runoff. Oil may also contaminate groundwater if it penetrates through the soil to the free water level.

Virtually all water quality parameters can be affected by solid waste and oil disposal practices.

More detailed information on impacts resuting from waste disposal sites may be found in the BLM Solid Waste Disposal Plan and Oil Spill Contingency Plan.

Minerals

The most serious pollutant arising from mining activities is the mine drainage generated by oxidation of pyritic materials with air in the presence of water; this drainage is an acidic mixture of iron salts, other salts and sulfuric acid. Mine drainage arises from both underground and surface mining sources, and from coal and many metal mining operations. Coal deposits and so-called hard rock mineral desposits are commonly associated with pyrite and marcasite, which are disulfides of iron. Acid mine drainage can find its way into surface waters, where the acid and sulfate may result in severe deterioration in stream quality. The acid can react with clays to yield aluminum concentrations sufficient for fish kills, and with limestone to yield very hard waters expensive to soften. The acid can also selectively extract heavy metals present in trace quantities in mineral and soil formations, resulting in toxic conditions in lakes and streams.

Mining refuse--waste materials left near the mining site after raw minerals have been cleaned or concentrated--is another source of pollution. Much of this refuse contains pyritic material which can be oxidized to acidic substances. The resultant acid water may remain in the pile until a rain-storm, at which time is is flushed into nearby water courses. Mine drainage "slugs" during storms are very detrimental to aquatic life in surface waters.

Mining operations also generate wastes, commmonly called spoil in the form of disturbed rock and oil. If this spoil is left in piles, erosion and runoff will carry sediment into streams. This sediment is capable of destroying life in streams, results in decreased capacity of streams and reservoirs, and destroys fish and wildlife habitats. Improperly impounded

sediment may be released suddenly as a mud slide and thus poses a direct threat to life and property. Road construction for access to mines may also contribute sediment to streams.

Mining activities have a pronounced effect on groundwater supplies. The various operations used to mine the mineral deposits can result in alteration of groundwater distribution patterns. Aquifers containing good water can become contaminated because mining may disturb bedrock formation, which permits mixing of contaminated water with good.

In the western United States, raw metal ores of copper, gold, and silver, etc., are treated so that concentrated ores can be economically shipped to smelters or other metal refiners. The waste residue left after the concentration process is retained in ponds. Unless these ponds are carefully sealed, salts will leach into groundwater which can be affected at a considerable distance from the source. If ponds are located on impervious rock, water trickling through the impounded solids will be discharged as polluted leachate in a spring at the foot of the impoundment.

The above-mentioned water-quality problems can occur at abandoned mine sites as well as at on-going mining operations.

Diversions and Return Flows

Water diversions and return flows resulting from power generation or irrigation are water quality problems that may have an impact upon public lands. The BLM does not directly authorize water allocations for diversion since water rights and allocations are a function of the State of California. The water quality problem assessment identifies diversions and return flow in terms of their effects on BLM water resources.

Diversions of water for irrigation and power generation can adversely affect water quality and aquatic habitat. When flows are reduced below minimum instream flow requirements, stressful conditions result for stream inhabitants. Adequate flows are required to maintain conditions favorable for the propagation of fish and aquatic macroinvertebrates.

Return flows resulting from power diversions and agricultural irrigation use may have an adverse impact on water quality. Land application of irrigation waters leads to an increase in the concentration of total dissolved solids and sediment. Stream water temperatures may also increase to levels which are detrimental to aquatic fauna. Irrigation return flows also carry increased levels of nitrogen, phosphorus and in some cases pesticides. Additional nutrient loadings can increase the growth of aquatic vegetation and pesticides may be detrimental to the development of aquatic fauna.

Chapter 2

BENEFICIAL USES OF WATER

The main objective of water quality management as delineated by the Porter-Cologne Act[1/] is to protect all waters for use and enjoyment by the people of the State of California. Activities and factors which may affect the quality of waters are regulated to attain the highest degree of water quality, considering all demands being made for the waters in a basin. Implicit in this objective is the necessity for the establishment of a beneficial use classification for all waters in the State.

Existing and potential beneficial uses of waters within a natural basin are the focal point for establishing water quality management objectives. The beneficial use concept is the key to rational water quality management. Water quality objectives which are based on beneficial uses are formulated according to the highest or most important beneficial use category within a basin. Management for the highest beneficial use assures that other uses within the basin are protected.

The Bureau of Land Management is responsible for protecting the benefical uses of its waters as well as waters downstream from BLM administered land. BLM's water quality management policy is based on State designated beneficial uses if they are more restrictive in terms of water quality objectives and appurtenant standards. The Bureau of Land Management must also maintain or enhance naturally existing water quality conditions in accordance with the Nondegradation Policy[2/].

1/ The Porter-Cologne Act and directives enacted pursuant to its objectives are contained within Division 7 of the State Water Code. The State Water Resources Control Board is responsible for the formulation and adoption of State policy for the control and management of water quality. Additionally, nine Regional Water Quality Control Boards have been established to develop Water Quality Control Plans which establish water quality management objectives on a regional basis.

2/ The Statement of Policy with Respect to Maintaining High Quality of Waters in California, referred to here as the "Nondegradation Policy," is intended to maintain the existing high quality of waters in areas where existing water quality conditions exceed estalished water quality management objectives. Wherever this condition exists, such a high degree of water quality will be maintained unless it can be demonstrated that any change will be consistent with maximum benefit to the people of the State and will not unreasonably affect present and anticipated beneficial uses of such water.

The Nondegradation Policy implies that water quality impacts be evaluated for all Bureau activities regardless of the magnitude of potential effects on natural water quality conditions.

The following sections of this chapter identify the existing and potential beneficial uses of all waters within the State of California that may be affected by BLM activities. The beneficial uses identified in this chapter were obtained from Regional Water Quality Control Plans published by the State Water Resources Control Board. The beneficial uses which the Bureau of Land Management makes of these waters are included in the problem assessment descriptions for each hydrologic area.

BLM Water-Quality Management

Historically, water quality management has been a support activity for other resources managed by the Bureau of Land Management. The Bureau of Land Management manages water resources for both consumptive and nonconsumptive uses. Consumptive beneficial use is usually restricted to providing drinking water at campgrounds and other recreational facilities, and for livestock and wildlife. Nonconsumptive beneficial uses include contact and non-contact forms of recreation, habitat for fisheries and wildlife in the riparian zone, and aesthetic enjoyment. The demand for nonconsumptive uses is expected to increase more rapidly than the demand for consumptive uses on Bureau lands. The increasing demand for non-consumptive water uses on public lands may have a negative impact on consumptive uses downstream if proper steps are not taken to protect water quality.

Water quality impacts of land management activities on beneficial uses must be considered on a site specific basis. Each management activity or on-the-ground action may potentially affect physical and chemical parameters of water. The parameters affected must be determined for each site specific problem through a field montoring program. Water quality management decisions should be based on the potential negative impacts of a land management activity on a particular downstream beneficial use.

In the past, the Bureau has been unaware of downstream State-designated beneficial uses in many cases and has not taken water quality impacts into account when evaluating a proposed ongoing activity. Future Bureau management activities must adequately evaluate all downstream uses of water resource before sound management decisions involving water quality can be made.

The beneficial uses which must be protected by the Bureau of Land Management may be different from State-designated beneficial uses in some major drainage basins. When Bureau-designated beneficial uses are more restrictive than State designated uses in terms of water quality requirements, water quality immediately downstream from Bureau lands can be expected to meet the requirements of all downstream users. The Bureau must upgrade land management practices to enhance water quality in areas where downstream beneficial uses are more restrictive than Bureau on site uses.

The following sections of this chapter identify the existing and potential beneficial uses of all waters within the State of California that may be affected by BLM activities. The beneficial uses identified in this chapter were obtained from Regional Water Quality Control Plans published by the State Water Resources Control Board. The beneficial uses which the Bureau of Land Management makes of these waters are included in the problem assessment descriptions for each hydrologic area.

California Water-Quality Management

State designated beneficial water uses have been established for many surface and subsurface waters passing through or underlying public lands in California. Table 2-1 lists all waters for which existing and potential beneficial uses have been established. These waters are the focal point for Bureau water quality management and planning in that Bureau actions may affect these beneficial uses. Bureau of Land Management designated uses of these water resources are not included in Table 2-1. They are addressed in the following section and in the problem area identification on a site specific basis.

Table 2-1 lists both existing (E) and potential (P) beneficial uses. Potential beneficial uses must be protected to the same extent as existing uses even though waters are not currently being utilized. Virtually all present and foreseeable future beneficial uses center around satisfaction of domestic and industrial needs, irrigation, maintenance of aquatic habitat and associated recreational activities. Non-consumptive uses are expected to increase substantially over the next 30 years due to the continued public demand for water oriented forms of recreation. Other important nonconsumptive uses include wildlife habitat, aesthetics and wild and scenic rivers.

In 1972, Senate Bill 107, The California Wild and Scenic Rivers Act, was passed which broadened the State definition of beneficial use to include a wild and scenic river system. The act declares "that the use of water for scenic, fishery, wildlife and recreation purposes in connection with such waterways is a beneficial use". Portions of the following rivers have been designated under the Wild and Scenic Rivers Act: Klamath, Scott, Salmon, Trinity, Now, Smith, and its tributaries, Eel, Van Duzen, North Fork American, and the Lower American.

The beneficial use categories designated by the State Water Resources Control Board are defined below.

MUN — Municipal and domestic Supply — Includes usual uses in community or military water systems and domestic uses from individual water supply systems.

AGR — Agricultural Supply — Includes crop, orchard, and pasture irrigation; stock watering; and support of farming and ranching operations.

IND — Industrial Service Supply -- Includes uses which do not depend primarily on water quality, such as mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization.

PROC — Industrial Process Supply -- Includes process water supply and all uses related to the manufacturing of products.

GWR — Groundwater Recharge -- Natural or artificial recharge for future extraction for beneficial uses and to maintain salt balance or halt saltwater intrusion into freshwater aquifers.

FRSH Freshwater Replenishment -- Provides a source of fresh water for replenishment of inland lakes and streams of varying salinities.

NAV Navigation -- Includes commercial and naval shipping.

POW Hydropower Generation -- Used for hydropower generation.

REC 1 Water Contact Recreation -- Includes all recreational uses involving actual body contact with water, such as swimming, wading, watersking skin diving, surfing, sport fishing, uses in therapeutic spas, and other uses where ingestion of water is reasonably possible.

REC 2 Non-Contact Water Recreation -- Recreational uses which involve the presence of water but do not require contact with water, such as picnicking, sunbathing, hiking, beachcombing, camping, pleasure boating, tidepool and marine life study, hunting, and aesthetic enjoyment in conjunction with the above activities as well as sightseeing.

COMM Ocean Commercial and Sport Fishing -- The commercial collection of various types of fish and shellfish, including those taken for bait purposes, and sport fishing in ocean, bays, estuaries, and similar nonfreshwater areas.

WARM Warm Freshwater Habitat -- Provides a warm-water habitat to sustain aquatic resources associated with warm-water environment.

COLD Cold Freshwater Habitat -- Provides a cold-water habitat to sustain aquatic resources associated with cold-water environment.

BIOL Preservation of Areas of Special Biological Significance - Includes marine life refuges, ecological reserves, and designated areas of special biological significance, such as areas where kelp propagation and maintenance are a feature of the marine environment requiring special protection.

SAL Saline Water Habitat -- Provides an inland saline water habitat for aquatic and wildlife resource.

WILD Wildlife Habitat -- Provides a water supply and vegetative habitat for the maintenance of wildlife.

RARE Preservation of Rare and Endangered Species -- Provides an aquatic habitat necessary, at least in part, for the survival of certain species established as being rare and endangered.

MAR Marine Habitat - Provides for the preservation of the marine ecosystem including the propagation and sustenance of fish, shellfish, marine mammals, waterfowl, and vegetation such as kelp.

MIGR Fish Migration -- Provides a migration route and temporary aquatic environment for anadromous or other fish species.

SPWN Fish Spawning -- Provides a high quality aquatic habitat especially suitable for fish spawning.

SHELL Shellfish Harvesting -- The collection of shellfish such as clams, oysters, abalone, shrimp, crab, and lobster for either commercial or sport purposes.

TABLE 2-1 (continued)
STATE DESIGNATED EXISTING (E) AND POTENTIAL (P) BENEFICIAL USES

	MUN	AGR	IND	PROC	GWR	FRSH	NAV	POW	REC 1	REC 2	COMM	WARM	COLD	BIO	SAL	WILD	RARE	MAR	MGR	SPWN	SHELL
REDDING DISTRICT																					
Feather River (E Branch)	E	E						E	E	E		P	E			E				E	
Shasta Valley	P	E	P	P	E	E		P	E	E		E	E			E			E	E	
Scott Valley	P	E	P	P	E	E			E	E			E			E			E	E	
Upper Trinity River	E	E	E	P	E	E			E	E			E			E			E	E	
Lower Klamath River	E	E	P	P	E	E	E		E	E	E	E	E			E			E	E	
Sacramento River (Shasta Dam to Colusa Basin)	E	E	E				E	E	E	E		E	E			E			E	E	
Whiskeytown Reservoir	E	E					E	E	E			E	E			E			E	E	
Cow Creek	P	E					E	E	E				E			E			E	E	

Cottonwood Creek	E	E	P	P			P	E	E	E	E	E		E	E
Stoney Creek		E						E	E	E	P	E		E	E
Butte Creek	E	E					E	E		E	E	E		E	E
<u>RIVERSIDE DISTRICT</u>															
GROUNDWATER															
Upper Mojave Subunit	E	E	E			E									
Middle Mojave Subunit	E	E	E			E									
Lower Mojave Subunit	E	E	E			E									
Afton Subunit	E	E	E			E									
Imperial Unit	E		E												
Anza-Borrego Unit	E	E	E												
SURFACE WATER															
San Felipe Creek					E			E	E	E			E		

Piute Springs	E			E			E	E	E			E
Colorado River below Needles-Topock Bridge	E	E	E	E		E	E	E		E	E	E
Colorado Hydrologic Unit Drains and Streams				E				E			E	
Santa Ana River	E	E		E	E		E	E			E	

TABLE 2-1 (continued)
STATE DESIGNATED EXISTING (E) AND POTENTIAL (P) BENEFICIAL USES

	MUN	AGR	IND	PROC	GWR	FRSH	NAV	POW	REC 1	REC 2	COMM	WARM	COLD	BIO	SAL	WILD	RARE	MAR	MGR	SPWN	SHELL
SUSANVILLE DISTRICT																					
Cedar Creek	E	E			E				E	E			E			E					
Emerson Creek		E			E				E	E			E			E					
Silver Creek		E			E				E	E			E			E					
Bare Creek		E			E				E	E			E			E					
Sand Creek		E			E				E	E			E			E					
Boot Lake		E			E					E			E			E					
Dodge Reservoir		E			E				E	E											
Red Rock Creek		E			E				E	E			E			E					
Dry Creek		E			E					E			E			E					
Long Valley Creek		E			E				E	E		E	E			E					

Susan River	E	E	E	E	E		E	E		
Willow Creek	E		E	E	E	E	E	E		
Papoose Creek	E		E	E	E		E	E	E	
Merrill Creek	E		E	E	E		E	E	E	
Eagle Lake	E			E	E		E	E	E	
Smoke Creek	E		E	E	E		E	E		
Smoke Creek Reservoir	E		E	E	E		E	E		
Petes Creek	E		E	E	E	E	E	E		
Fitshugh Creek	E			E		E	E	E		E

TABLE 2-1 (continued)
STATE DESIGNATED EXISTING (E) AND POTENTIAL (P) BENEFICIAL USES

	MUN	AGR	IND	PROC	GWR	FRSH	NAV	POW	REC 1	REC 2	COMM	WARM	COLD	BIO	SAL	WILD	RARE	MAR	MGR	SPWN	SHELL
SUSANVILLE DISTRICT																					
Selic Canyon Creek		E							E			E	E			E				E	
Sheep Valley		E							E			E	E			E				E	
Cedar Creek		E							E			E	E			E				E	
Pine Creek		E							E			E	E			E				E	
Payne Reservoir		E							E			E	E			E				E	
Ash Creek		E							E			E	E			E	E			E	
UKIAH DISTRICT																					
Klamath River	E	E	P	P	E	E	E		E	E	E	E	E			E			E	E	
Smith River	E	E	E	P	E	E			E	E			E			E			E	E	

Clear Lake	E	E					E	E			E	E			E				E	
Lake Berryessa	E	E					E	E			E	E			E				E	
Eel River	E	E	E	E			E	E			E	E			E			E	E	
North Coastal King Range		E	E				E	E			E	E			E			E	E	
North Coastal South	P	E	E				E	E			E	E			E			E	E	
Russian River	E	E					E	E			E	E			E			E	E	
North Bay Region	E	E	E	E			E	E			E	E			E			E	E	

U.S. Bureau of Land Management
WATER QUALITY
PROBLEM ASSESSMENT
BLM DISTRICT / WRCB BASIN LOCATION MAP
BLM District Boundaries
WRCB Basin Planning Area Boundaries
REDDING DISTRICT
SUSANVILLE DISTRICT
UKIAH DISTRICT
FOLSOM DISTRICT
BAKERSFIELD DISTRICT
RIVERSIDE DISTRICT
1A
1B
2
3
4A
4B
5A
5B
5C
5D
6A
6B
7A
7B
8
9
WRCB Basin Planning Areas
1A - Klamath River
1B - North Coastal
2 - San Francisco Bay
3 - Central Coastal
4A - Santa Clara River
4B - Los Angeles River
5A - Sacramento River
5B - Sacramento - San Joaquin Delta
5C - San Joaquin
5D - Tulare Lake
6A - North Lahontan
6B - South Lahontan
7A - West Colorado River
7B - East Colorado River
8 - Santa Ana River
9 - San Diego

Figure 3-1

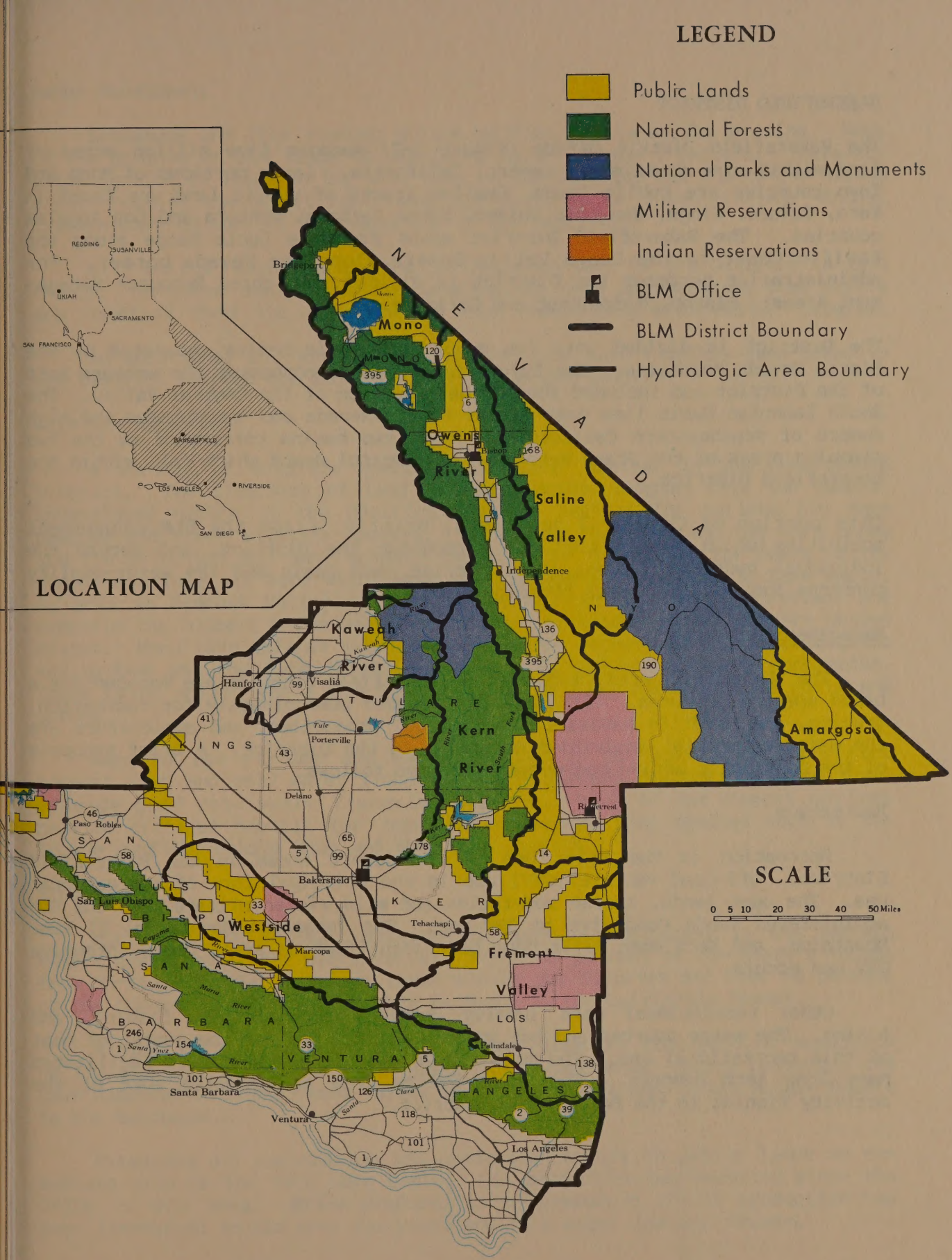
Chapter 3

IDENTIFIED WATER-QUALITY CONCERNS

This chapter presents the water quality problems that have been identified in the six California BLM Districts.

In addition to the problem descriptions, each District and the hydrologic areas within a District are briefly discussed in order to give the reader background information to help in attaining a "feel" for the problems. Also, these discussions are presented at this time to simply describe the Districts and pertinent hydrologic information.

The problem assessment analysis is subjective and qualitative. Many problem areas should be studied in greater detail to determine cause and effect relationships between land uses and water quality. Beneficial uses for BLM waters need to be identified in areas where the potential for multiple water uses exist. Figure 3-1 depicts the BLM Districts and the California water Control Board Basins.



BAKERSFIELD DISTRICT

Figure 3-2

BAKERSFIELD DISTRICT

The Bakersfield Distrit Office (Figure 3-2) manages five million acres of land within nine counties in central California. Large portions of Mono and Inyo counties are public lands. Smaller tracts of public land are found in Kern, Tulare, Kings, San Luis Obispo, Santa Barbara, Ventura and Los Angeles counties. The Bakersfield District spans from the Lucia Range along the Pacific Coast to the Death Valley Desert along the Nevada border. For administrative purposes the District is divided into three Resource Management Areas: Bishop, Ridgecrest and Caliente.

The District is divided into two major hydrologic basins separated by the Sierra Nevada Mountains. The Tulare Lake Basin encompasses the western half of the District and includes the southern portion of the Central Valley. The South Lahontan Basin lies east of the Sierra Nevada and encompasses the high desert of southeastern California. These two basins correspond to the two planning areas of the State Water Quality Control Board which fall within the Bakersfield District.

This portion of Chapter 3 describes, briefly, first the BLM management activities which are carried out throughout the District, and second the individual hydrologic areas that comprise each basin and the water-quality concerns identified in each hydrologic area.

Management Activities

The BLM administered lands of the Bakersfield District are managed for a broad spectrum of uses. BLM lands are managed predominately for recreation, grazing, and wildlife habitat. Mining, oil production, and agriculture are the major commercial activities occurring in the District. A brief synopsis of the District's active management programs follows.

Recreation

Recreation is the major use of the desert areas in the Bakersfield District. Off-road vehicle (ORV) use is the principal form of recreational use. The open lands, sparse vegetation and mild winter climate make the BLM administered lands conducive to ORV use. The Tehachapi Mountains, El Paso Mountains, and Kettleman Hills have been identified as areas where intensive ORV use occurs.

Other recreational uses involve camping, rockhounding, fishing, and hiking. The water sources and hot springs attract and are the center of most of this recreational use. The mild winter climate of the desert facilitates many long term campers. The Owens Valley area accommodates most of the activity fishing in the Bakersfield District.

Range Management

Livestock and free roaming burros utilize BLM lands for grazing. Most of the grazing on BLM lands is allocated under Section 3 permits. There are a few Section 15 lands on the west side of the District and around the Bishop area. Much of the desert rangelands are utilized for sheep grazing. Annual grasses make up most of the rangeland in the District.

Wild burros heavily graze the northeastern part of the District in Inyo County. Resource damage from overgrazing has been so extensive that burros are exported from the area through the "Adopt-A-Horse-or-Burro" program.

An additional 250,000 acres of grazing land have recently been added to the District through the Bodie-Coleville Planning Unit.

Wildlife Management

A variety of wildlife species find their habitat in the Bakersfield District. The diversity of land characteristics, coupled with the general undeveloped nature of the District provides habitat for various big game species and other wildlife species. Mule deer, Tule elk and big horn sheep are the principal big game animals found in the District. The Owens Valley supports a Tule elk herd which were once indigenous to the Tule Lake Basin. An area in Fremont Valley is outstanding habitat for desert tortoises and supports the highest known density of desert tortoises in the western United States. Mono Lake islands provide an important rookery for California gulls and grebes and the Lake itself supports a unique brine shrimp population. These brine shrimp are a critical link in the food chain for the gulls and grebes.

Many of the streams and water sources in the Bakersfield District support warm and cold water fisheries. The streams feeding the Owens River provide good cold water fisheries habitat. Many of the desert springs provide critical habitat for rare and endangered fish species such as the Tecopa pupfish, Mohave Chub and the Owens pupfish.

Minerals

Mining occurs on BLM administered lands predominately in the eastern desert areas and in the Owens Valley. About 60 percent of the State's income from minerals is derived from lands within the District and over 90 percent of the borate in the United States is found in the California Desert.

Mining for locatable minerals is not directly regulated or monitored by the BLM because of the 1872 mining law. Geothermal energy potential has been discovered in the Owens Valley to the northeast and in the Mojave Desert to the southeast.

Extensive oil exploration and production occurs on public lands on the western side of the Tule Lake Basin. Oil production has occurred since the 1920s in this area. Brine produced as a by-product of oil production has been discharged in the area for years and is a water quality concern.

Tulare Lake Basin

The Tulare Lake Basin is the southern extension of the Central Valley and is bordered on the east by the Sierra Nevada Mountains, the south by the Tehachapi and San Emigold Mountains, and the west by the Coast Range. The Basin is a great structural downwarp between two zones of uplift. The valley floor is covered by deposition from the Sierra Nevada and Coastal Range Mountains and is approximately 25,000 feet thick.

The valley previously contained a large body of water and presently has some dry lakes and interconnecting sloughs. The alluvial plains of the valley grade into the foothills of the Sierra Nevada Mountains and the Coastal Range. The major drainages are the Kern River and the Kaweah River. The Tulare Lake Basin is a major groundwater basin and is made up of three distinct bodies of groundwater. These bodies are unconfined and semi-confined, confined, and saline connate groundwater. Groundwater movement and recharge are important to the agriculture industry of the valley.

The climate in the Tulare Lake Basin varies greatly from desert valleys to the alpine climate of the Sierra Nevada Mountains. The Coastal and Sierra Nevada Mountains block the major air masses from the Tulare Lake Basin thereby isolating the valley from climatic influences. The mean annual temperature in the valley is about 65`F with summer temperatures in the 100`F range. The mountain areas experience four district seasons with cold winters and mild summers. Air movement in the foothills of the Sierra Nevada Mountains creates a "thermal belt" which is warmer and relatively frost free. Precipitation varies from 5 inches annually in the valley to 50 inches in the mountains. Fog is common in the winter. Precipitation predominately occurs during the six month winter-spring period.

Kern River Hydrologic Area

The Kern River Hydrologic Area is located at the southern end of the Sierra Nevada east of Bakersfield, California. The Kern River is the major hydrologic feature in the area. It originates in the Sierra Nevada, supplies Lake Isabella, and then flows toward Bakersfield. In most years, the river is completely consumed for irrigation before it reached Bakersfield. However, during water surplus years the river reaches its final destination in the Buena Vista Lake Basin. The BLM lands in the area are located principally around the Lake Isabella region. The upper watershed is part of the Sequoia National Forest.

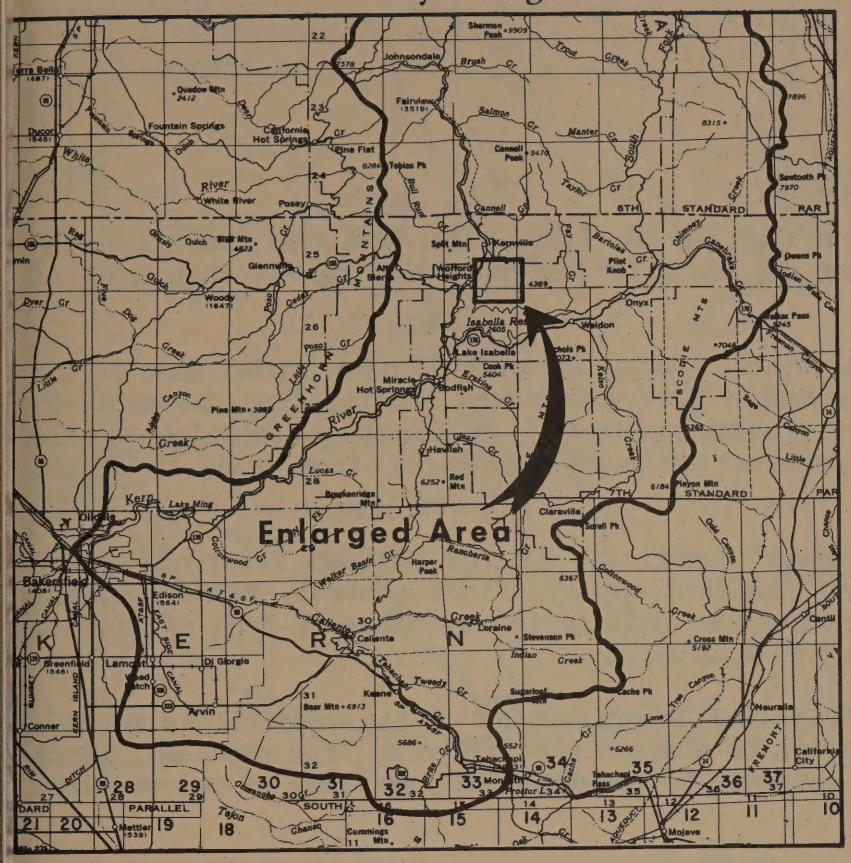
Precipitation varies throughout the area from 5 to 25 inches annually. The Bakersfield area is the driest portion while the upper reaches of the Kern River receive the greatest amounts of precipitation, primarily in the form of snow. Vegetation varies from timbered mountain to dry lake basin-desert.

Beneficial uses of the water resources in the Kern River Hydrologic Area include irrigation, recreation, grazing, groundwater replenishment and reservoir supply.

U.S. Bureau of Land Management
BAKERSFIELD DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

KERN COUNTY DUMP

Kern River Hydrologic Area



LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands
- Military Withdrawals

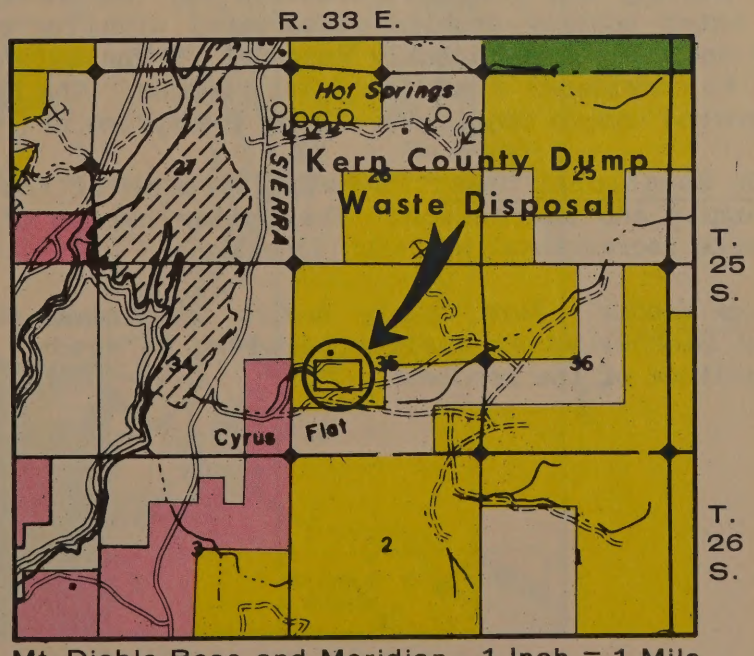


Figure 3-3

Waste Disposal Sites

Kern County Dump (Existing)

The Kern County Dump in Section 35, T25S, R33E. MDM., is located on BLM administered lands adjacent to Isabella Reservoir and serves that area of Kern County.

Heavy rains during the winter and spring of 1978 have eroded some of the fill. The proximity to Isabella Reservoir makes erosion from the sanitary landfill a critical water quality problem. Either poor location of the sanitary landfill or inadequate protective measures from high flows has caused the erosion of the fill.

Effect On Beneficial Uses: Beneficial uses of Isabella Reservoir waters are recreation, irrigation, domestic supply, flood control, fisheries, and aesthetics. All of these uses can be affected by material from a sanitary landfill being washed into the reservoir.

Information Needs: Review of the placement of the landfill is needed. Mitigating measures are needed to protect the fill area from eroding. Water quality samples should be obtained to document the magnitude of the problem.

Recreation

Kern River (Existing)

The Kern River downstream from Isabella Reservoir crosses BLM administered lands for approximately three miles. The Kern River originates in Sequoia National Forest and flows into the South Central Valley Basin. Flows are regulated below the dam and during drought conditions the river has very little flow.

Camping, fishing and general recreation day use along the Kern River have created water quality problems associated with recreation use. The water quality has been significantly degraded to the extent that the river below the dam is considered a public health problem. The Kern County Health Department reported unsafe conditions during the spring of 1978.

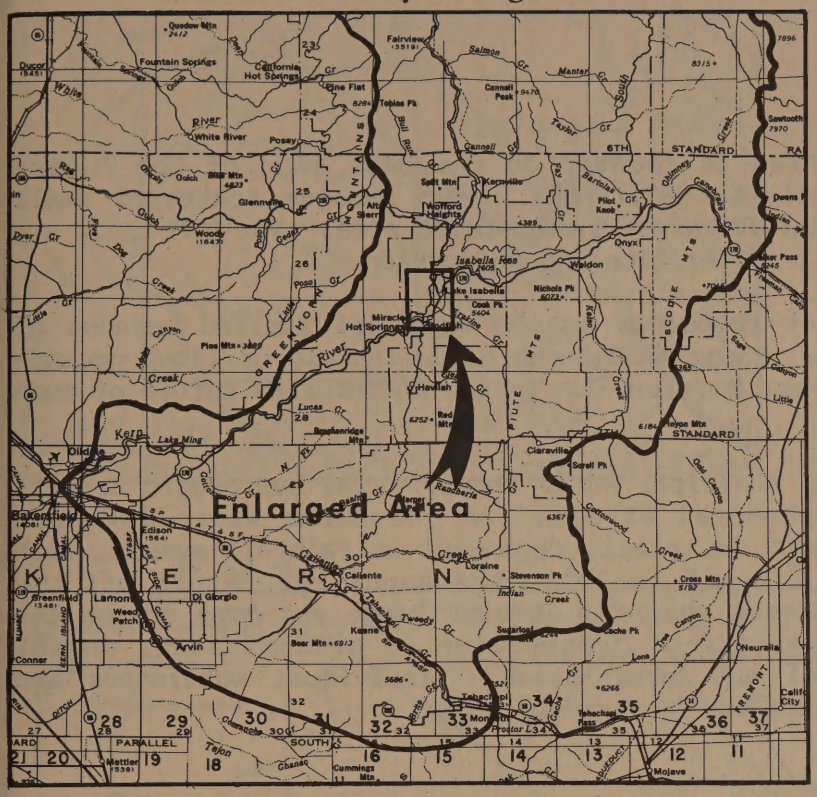
Effect On Beneficial Uses: Beneficial uses of the Kern River are irrigation supply and recreation. The contamination of the Kern River adversely affects recreational use significantly.

Information Needs: Kern County Health Department records should be evaluated and further water quality sampling is needed to identify the extent and magnitude of the problems.

U.S. Bureau of Land Management
BAKERSFIELD DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

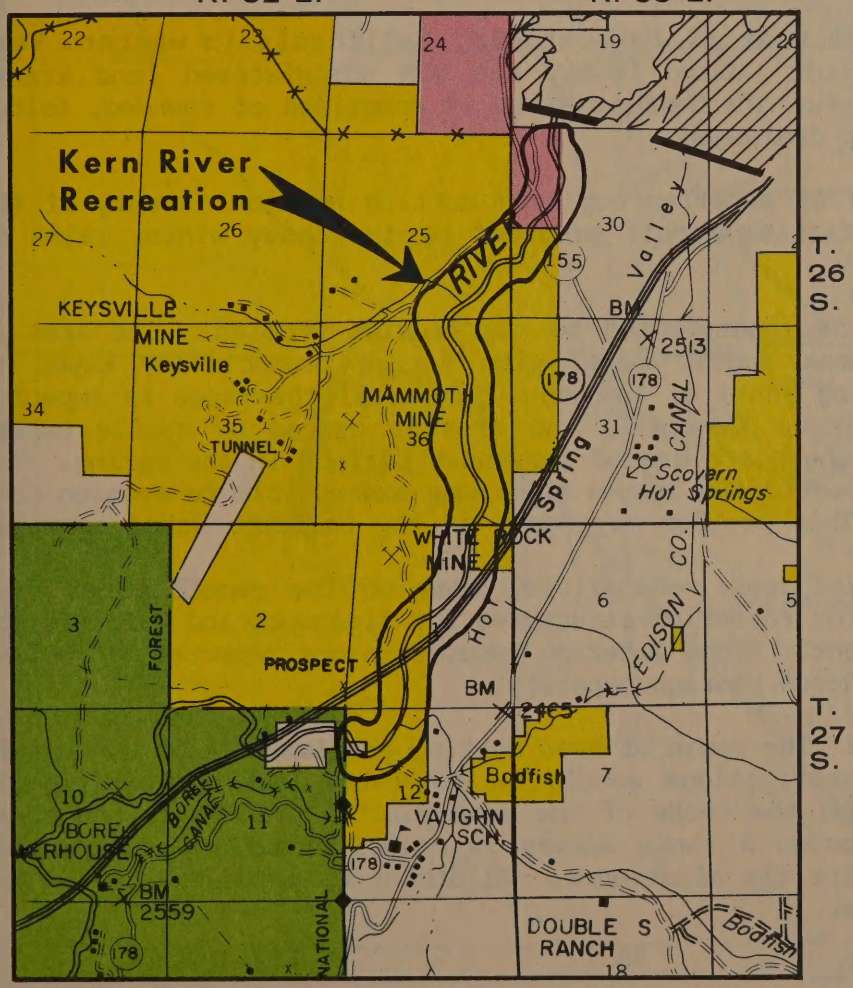
KERN RIVER

Kern River Hydrologic Area



LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands
- Military Withdrawals



Mt. Diablo Base and Meridian 1 Inch = 1 Mile

Figure 3-4

Westside Hydrologic Area

The Westside Hydrologic Area is located on the west side of the Tulare Lake Basin west of Bakersfield, California. BLM manages scattered small tracts throughout the Temblor Range in the Westside area. The BLM lands are utilized for grazing and oil exploration and production.

Beneficial use of the water resources in the area are limited because of the limited surface waters. Range management predominately utilizes groundwater. Wildlife is relatively abundant due to the undisturbed nature of much of the area.

The Cuyama River provides a municipal water supply. The hydrologic area is characterized by small ephemeral streams and the Buena Vista lake bed which is usually dry. Runoff is totally dependent on rainfall events, with the precipitation varying from 5 to 10 inches annually. Winds off the Pacific Ocean build into storms over the Temblor Range and move across the valley contributing precipitation. Vegetation is predominately annual grasses with some chaparral and brush areas. Individual watersheds are relatively small and characterized by rugged hills.

Grazing

Temblor Range (Existing)

The Temblor Range west of Bakersfield, California in western Kern County and east San Luis Obispo County has BLM administered land tracts scattered over the range. The Temblor Range is comprised of rounded, folded mountains with few deep drainages.

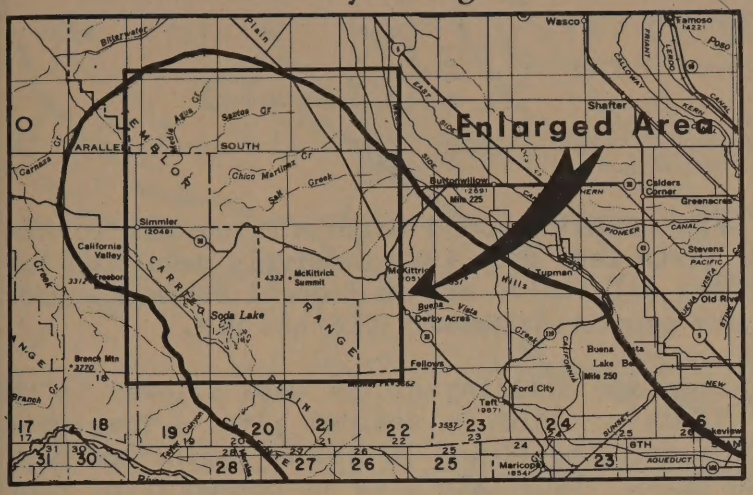
The Temblor Range is experiencing head cutting erosion in many of the drainages due to substantial runoff produced by the heavy winter rains of 1978.

Improper grazing has contributed to the erosion problem. The area is classed as Mediterranean annual type, with forage productivity keyed to winter moisture. During years of low winter rainfall the range is impacted significantly by grazing. Generally the area is grazed by cattle except during dry years when sheep are grazed for short periods in the spring. The removal of the annual vegetation leaves the range susceptible to erosion from summer rain storms. This problem may occur in the Caliente Range as well.

Effect On Beneficial Uses: Beneficial uses of the runoff water from the Temblor Range are for retention structures for livestock and wildlife and groundwater replenishment. Stock watering reservoirs are impacted by sedimentation resulting in reduced storage capacity.

Information Needs: The cause of head cutting erosion must be adequately determined. Field investigations should be completed looking specifically at soils, vegetation and the cause of the erosion. If grazing is the cause of the accelerated erosion a range survey is needed to update and provide proper stocking rates for the allotments. Allotment Management Plans (AMPs) are needed for the area.

Westside Hydrologic Area



U.S. Bureau of Land Management
BAKERSFIELD DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

TEMBLOR RANGE & KERN COUNTY

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)

R. 19 E. R. 20 E. R. 21 E. R. 22 E.

T. 28 S.
T. 29 S.
T. 30 S.
T. 31 S.

Kern County Groundwater Degradation

Temblor Range Grazing

Windmill
Quarry
Pumping station
Alex Cook Spring
Napoleon Spring
Walnut Spring
McAlister Ranch
Ross Ranch
Antelope Hills Oil Field
McDonald Anticline Oil Field
Bldg
SOUTH BELRIDGE OIL FIELD
Belridge
Water
Cotton gin
West Side
Underground pipeline
Chico Martinez Creek
Salt Creek
Temblor Creek
Oil Field
TEMBLOR VALLEY
McKITTRICK VALLEY
SAN LUIS OBISPO COUNTY
KERN COUNTY
Simmler
Tembor Ranch
Willow Spring
Frazer Spring
Cauvel Ranch
Kings Ranch
TV booster
Chicote Ranch
Sandiego Creek
LITTLE SANTA MARIA VALLEY
Sulphur Spring
McKittrick
SKYLINE
Gypsum
Oil
Ranch
Cooper Ranch
Werling Ranch
Goodwin Ranch
Soda Lake
Big Spring
Turkey Camp Well Ranch
Painted Rock Ranch
Wellman Ranch
Derby Acres
Crocker Canyon
Midway
CARRIZO PLAIN
ELK HILLS
TEMBLOR
1940
2271
4332
3957
3509
3931
3366
560
416
256

Mt. Diablo Base and Meridian

1/4 Inch = 1 Mile (Approximate)

Figure 3-5

Groundwater Degradation

Kern County (Existing)

The western portion of Kern County around Bakersfield, California and specifically near the Buena Vista Lake area is extensively developed for oil production. Portions of these oil fields are on Federal surface and/or Federal minerals and therefore are permitted through USGS and BLM.

Historically, production water and drilling fluids were allowed to be discharged to the surrounding lands or held in unlined pits. The water produced from separators and from drilling fluids is highly saline and high in TDS. The groundwater in the Buena Vista Lake area is presently of poor quality and quite saline due to improper reinjection, plugging, and water disposal in the past. Present enforcement by USGS of NTL 2B regulations has nearly eliminated the discharge of production water into unlined pits and closely evaluates reinjection procedures. Poor practices of water disposal in the past may have significantly altered aquifers to the point that pollution may be irreversible. Improper plugging allows for cross flow and mixing of separate aquifers permitting saline waters to mix with good aquifers.

Effects On Beneficial Uses: The beneficial use of many of these aquifers is drilling fluid, secondary recovery treatment, domestic supply, and agriculture. More water could be put to beneficial use by agriculture in Kern County if it were not so saline. Poor oil field practices in the past may have made much of the groundwater unusable.

Information Needs: Evaluation of reinjection procedures and plugging records is needed to insure proper water disposal and maintain aquifer integrity. Monitoring of groundwater alkalinity and total dissolved solids is necessary to evaluate changes in groundwater quality. Support and enforcement of NTL 2B should prevent any future degradation.

Recreation

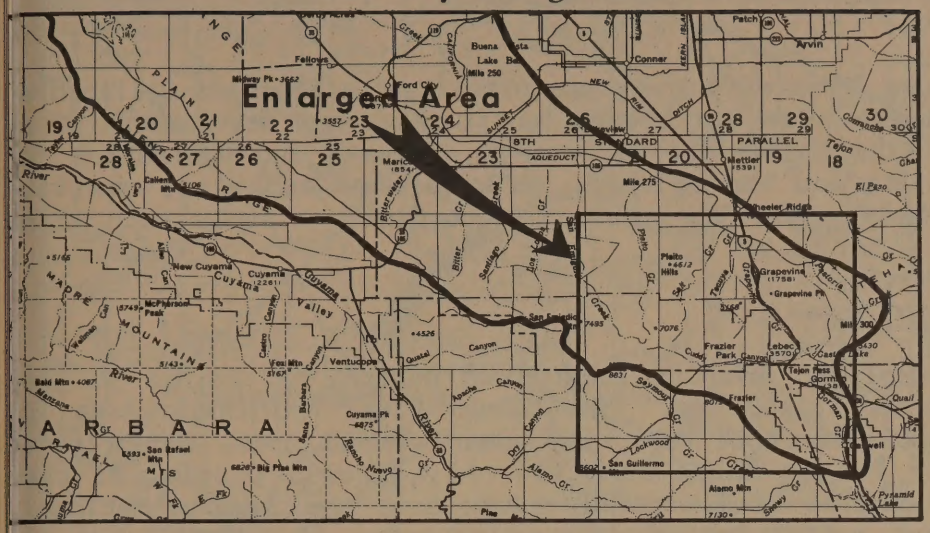
Gorman (Existing)

The Gorman area is adjacent to Interstate 5 north of the Angeles National Forest boundary. The lands can be described as those BLM administered lands in T7&8N, R18&19W, SBM and along the forest boundary in T10N, R18 and 19W.

The steep, open slopes and close proximity to the Los Angeles area make this a desirable ORV recreation area. The unconsolidated soils, Tertiary gravels, steep slopes and minimal vegetative cover make the area quite susceptible to severe erosion and mass soil movement. The use of the area by ORVs accelerates natural erosion. Destruction of the vegetation and shear force on surface soils from vehicle travel permits severe erosion during storm events. This area experienced massive erosion and slides during the winter and spring of 1978. Regulation and proper use of ORVs in the area would aid in the reduction of massive soil movement problems.

Effect On Beneficial Uses: The beneficial uses of the watershed are recreation and water supply to the City of Los Angeles system at Pyramid Lake. Massive soil erosion is detrimental to the Pyramid water supply.

Westside Hydrologic Area

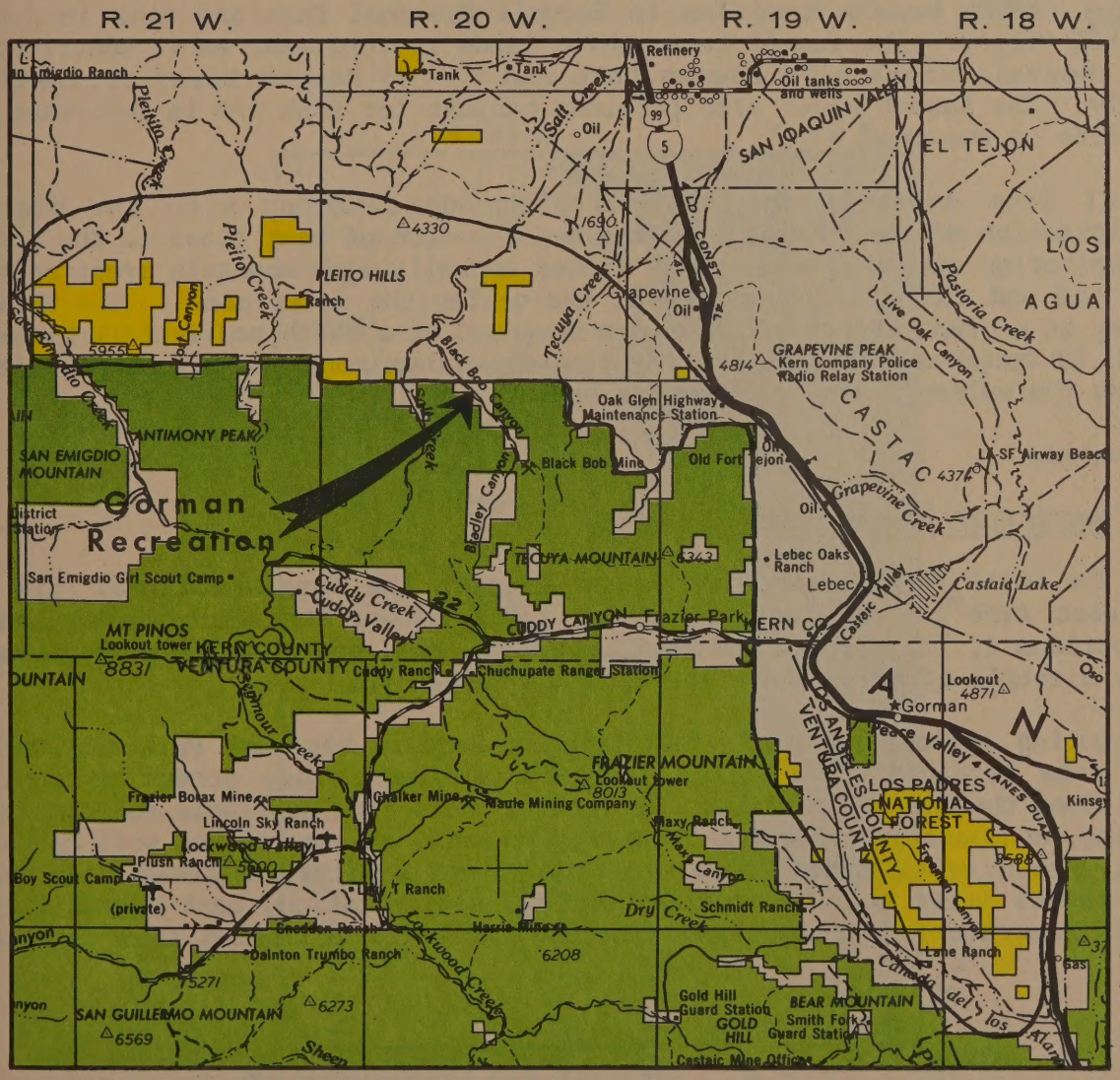


U.S. Bureau of Land Management
BAKERSFIELD DISTRICT
WATER QUALITY PROBLEM ASSESSMENT

GORMAN

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands



San Bernardino Base and Meridian ¼ Inch = 1 Mile (Approximate)

Figure 3-6

Information Needs: Presently there are plans by the State of California to acquire some of these lands for recreation purposes and development of a suitable ORV area. The California Department of Parks and Recreation is monitoring the ORV use and its relation to watershed and water quality conditions in this area. The BLM needs to coordinate closely with them during this process.

Kaweah River Hydrologic Area

The Kaweah River hydrologic Area is located in central California on the eastern side of the Central Valley. The Kaweah River Hydrologic Area is comprised of the Sequoia National Park, BLM administered lands, and private agricultural lands. Public lands comprise only a small portion of the hydrologic area and consist of scattered tracts near the Sequoia National Park boundary. Major activities which are occurring on public lands in the area include recreation and grazing.

The sequoias and rugged terrain of the upper Kaweah area have attracted recreational use at an increasing rate each year.

The Kaweah River is the major drainage in the area. Its headwaters originate in the Sierra Nevada Mountains in Sequoia National Park and flow into the Central Valley. The runoff from public lands is important as it contributes to reservoir storage in Kaweah Lake and to the Kaweah River irrigation supply. The Kaweah River also provides habitat for fish and is important to wildlife in the area.

Runoff from snowmelt in the Sierra Nevada combined with the higher precipitation of the foothills is the major source of peak flows in the area. Precipitation ranges from 10 to 50 inches annually with mountain areas on the high end and the alluvial plains of the valley the drier areas. The Tulare Valley is a great structural downwarp composed of a thick sedimentary blanket which is comprised of erosional debris of various mountain parent materials making the valley a good groundwater basin.

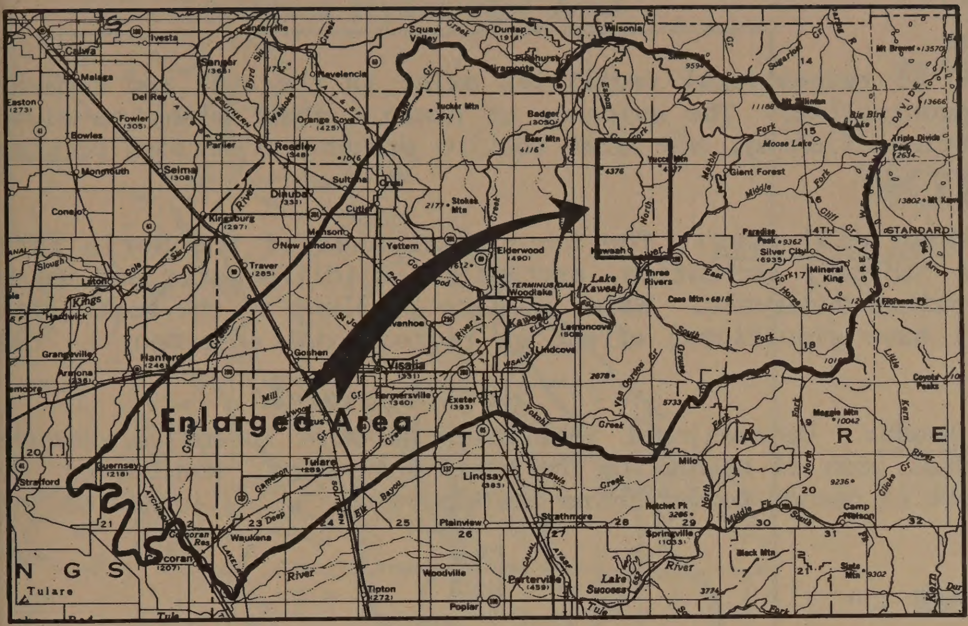
Recreation

North Fork Kaweah River (Existing)

The North Fork Kaweah River is adjacent to the Sequoia National Park on the east side of the Central Valley. It crosses BLM administered lands in Sections 2, 13, 23, 24, and 26, T16S, R28E, MDM, and flows into the Kaweah River a couple of miles above the Terminus Reservoir.

During periods of peak visitation in Sequoia National Park the North Fork area receives considerable recreational use. Easy access to public land along the North Fork Kaweah River makes this area desirable for camping, fishing, and general recreation. Heavy recreational use creates soil compaction, trampling of stream bank vegetation, and sanitary disposal problems. This causes water quality problems such as sedimentation, bank instability, water temperature increases and possible bacterial pollution from improper

Kaweah Hydrologic Area

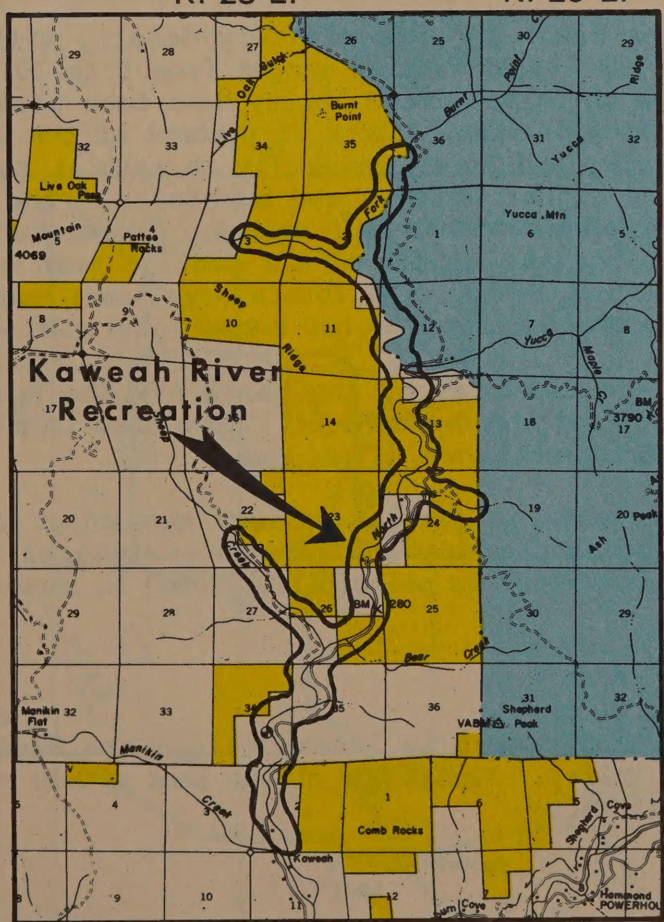


U.S. Bureau of Land Management
BAKERSFIELD DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

KAWEAH RIVER

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Park Lands



Mt. Diablo Base and Meridian   ½ Inch = 1 Mile

Figure 3-7

sewage disposal. No recreational facilities exist in the area and recreational use is uncontrolled. The evidence of human contact with the river from swimming, wading, fishing, and float boating presents a serious problem to water quality.

Effect On Beneficial Uses: The beneficial uses of the North Fork include fisheries habitat, recreation, aesthetics, wildlife water and water supply of the Terminus Reservoir. Water quality problems in the North Fork Kaweah River will have significant effect on recreational enjoyment in the area.

Information Needs: Recreational facilities or more intensive management of recreational uses is needed in the North Fork area. Monitoring for bacterial pollution is needed to determine the extent and significance of the problem.

South Lahontan Basin

The South Lahontan Basin extends from the Mono Lake Basin south to the Mojave Desert. The southern portion of the basin is characterized by broad valleys with internal drainage and barren mountain ranges. The desert area consists of consolidated sedimentary, igneous, and metamorphic rocks. Desert mountains consist of highly fractured or jointed rock of the basins. The Mono Lake Basin was formed by volcanic action and Sierra Nevada uplifting. The valleys in the basin are comprised of sedimentary deposits from the surrounding mountains.

The South Lahontan Basin is predominately desert, with little rainfall and hot temperatures. Precipitation ranges from 5 to 10 inches annually in most of the desert while the Owens Valley-Mono Lake area receives 8 to 35 inches of annual precipitation. About 75 percent of the basin precipitation falls between November and April, generally as rain at the lower elevations and as snow in the higher valleys and mountains. The desert areas are subject to short duration intense rain storms. Temperatures reach or exceed 100°F during five to eight months of the year in much of the basin. The mountain regions around Bishop, California have lower average temperatures, while the desert is characterized by hot summers and mild winters.

The major hydrologic features of the basin are the numerous lake beds, many of them saline, and the Owens River. Mono Lake is an ancient lake with unique saline characteristics and life forms.

Groundwater is available in various valleys throughout the South Lahontan Basin. Owens Valley is probably the largest groundwater basin in the South Lahontan Basin. Groundwater is principally stored in unconsolidated alluvial deposits.

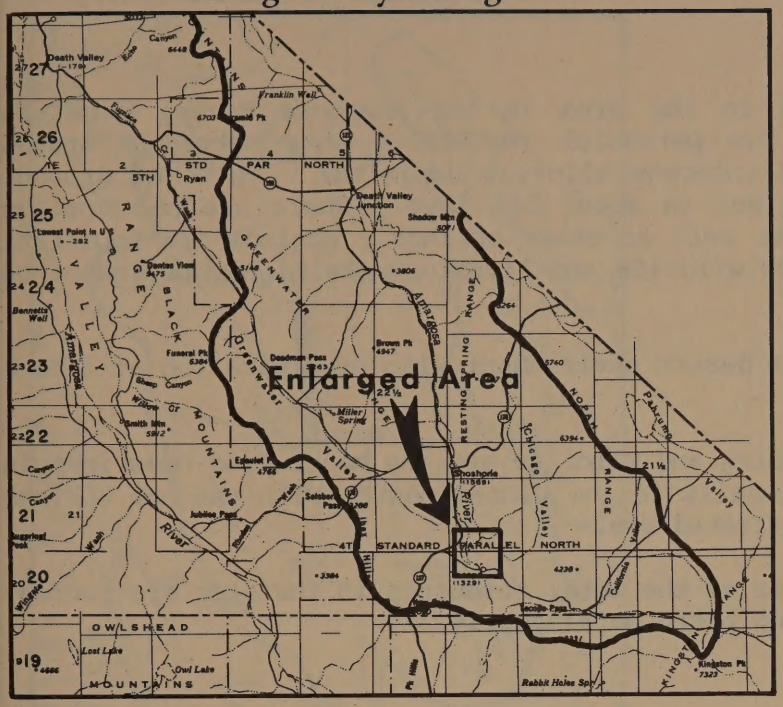
Amargosa Hydrologic Area

The Amargosa Hydrologic Area is located along the Nevada border on the east side of Death Valley. Almost all of the land within the hydrologic area is under BLM administration.

U.S. Bureau of Land Management
BAKERSFIELD DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

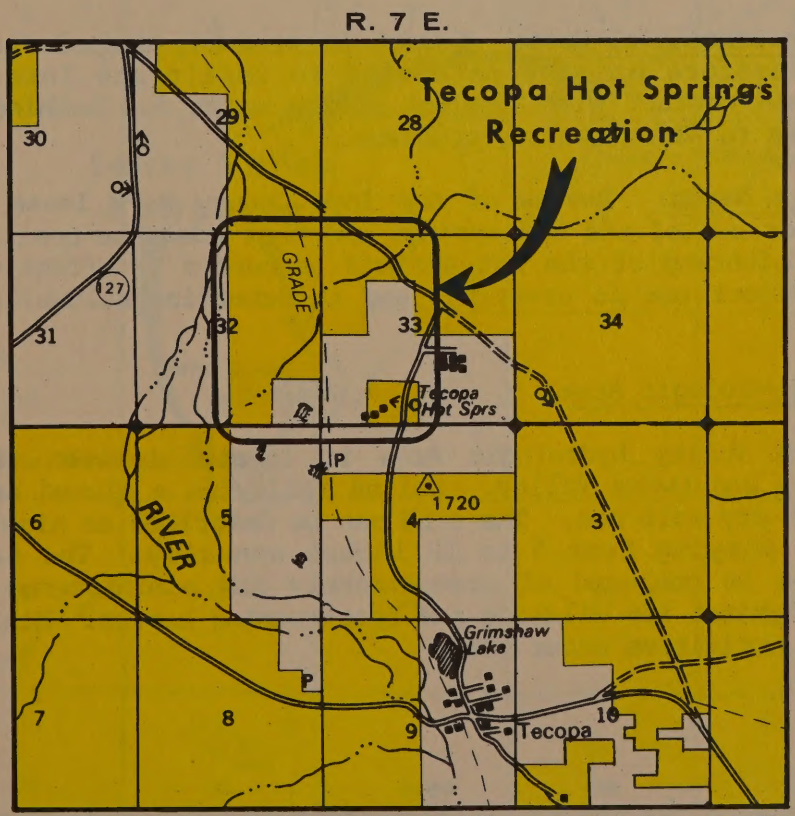
TECOPA HOT SPRINGS

Amargosa Hydrologic Area



LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)



San Bernardino Base and Meridian 1 Inch = 1 Mile

Figure 3-8

The principal drainage in the area is the Amargosa River, which is intermittent except for a few perennial reaches. Groundwater is stored mainly in the Recent and Pleistocene alluvial deposits. Depths of groundwater range from ground surface to about 540 feet. There are hot springs within the hydrologic area as well as other springs. Springs are important to the desert ecosystem since wildlife and livestock are highly dependent on them.

The area is considered a desert environment with precipitation at 4 to 8 inches annually.

Recreation, grazing, mining and wildlife are the major land uses in this area. Recreation occurs primarily in the winter months with the hot springs attracting much of the concentrated use.

The major beneficial uses of the water resources in the area are recreation, wildlife, livestock, and burro water supply.

Recreation

Tecopa Hot Springs (Existing)

The Tecopa Hot Springs are located in Inyo County east of Death Valley National Monument and west of the Nevada State line. The BLM administered lands directly affected are SE 1/4 SW 1/4, Sec. 33, T21N, R7E, MDM.

Recreational use, and particularly long term camping, is the primary beneficial use of the hot springs. No means of disposal has been provided for sewage generated by campers.

Effects On Beneficial Uses: Sewage is probably dumped directly on the ground and therefore has the potential to infiltrate into the shallow aquifers. Human contact with the hot spring water for bathing and soaking also contributes to water quality problems.

Information Needs: Review of the Inyo County R&PP lease should occur to insure proper use of the hot springs and that adequate health precautions are taken. Monitoring of the hot springs is needed to effectively evaluate the level of impact use is creating, and to determine suitability for human contact.

Saline Valley Hydrologic Area

The Saline Valley Hydrologic Area is located between the north end of Death Valley and Owens Valley. Saline Valley is a closed basin with the valley bottom a dry salt bed. The area can be described as high desert, with precipitation varying from 5 to 10 inches annually. The Saline Valley Hydrologic Area is composed of predominately BLM administered lands. The area provides habitat for wildlife and free-roaming burros. Mining, grazing, and recreation activities occur here.

Saline Valley Hydrologic Area

U.S. Bureau of Land Management
BAKERSFIELD DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

SALINE VALLEY SPRINGS

LEGEND

- Suspected Problem Area
- Patented Lands
- Public Lands (BLM)

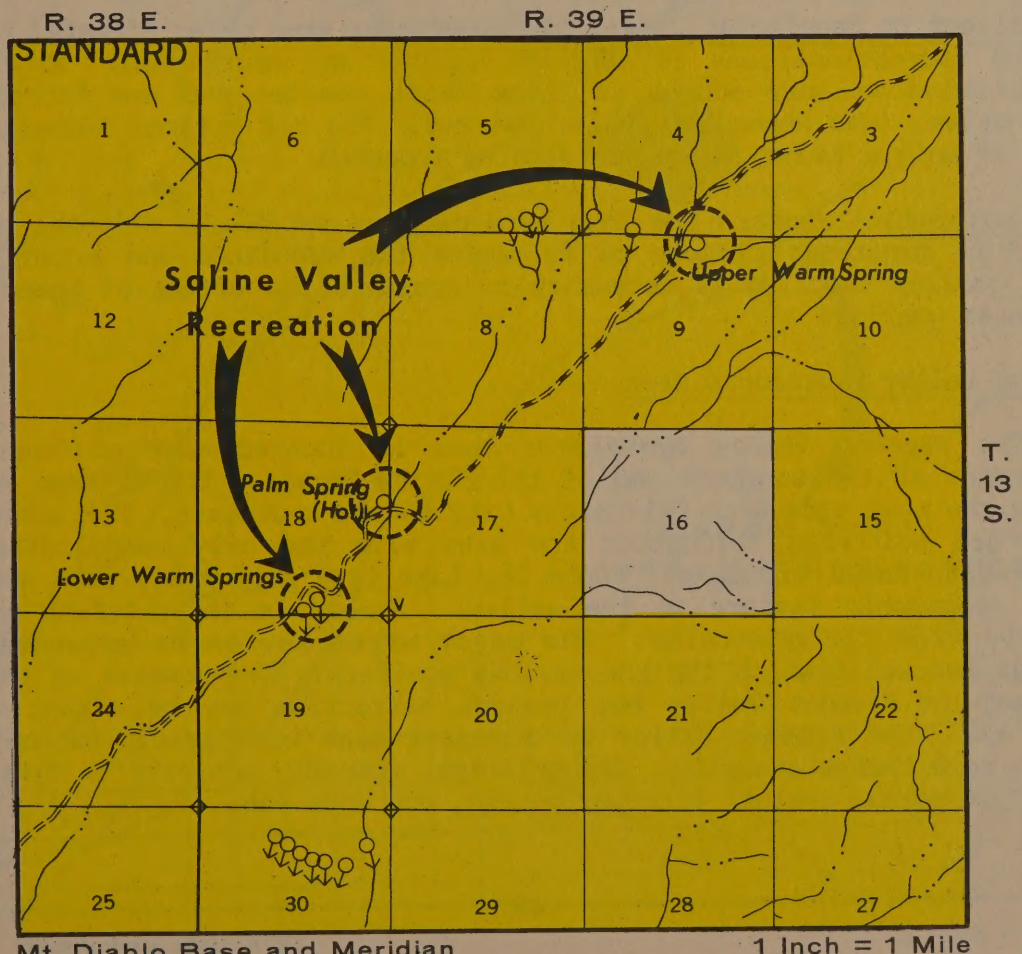


Figure 3-9

The area has a few popular hot springs located in the valley. The warm winter temperatures of the desert make the area desirable for recreation in the winter months. Open land is conducive for various forms of recreation, including ORV activity, rockhounding, and camping.

The water resources in the area are minimal and confined to the springs and water wells.

Recreation

Saline Valley Springs (Suspected)

Saline Valley is on the west side of Death Valley National Monument at the southern end of the Owens Valley in eastern California. Saline Valley springs are scattered in the central portion of the valley. The springs are: Upper Warm Spring, Section 9, T13S, R39E, MDM.; Palm Spring (hot) and Lower Warm Spring in Section 18, T13S, R39E, MDM; and other water sources in the valley.

These water sources are subject to recreational use and long term camping on the adjacent lands. Continued human contact with the springs for bathing and soaking, sewage disposal in the area, and compaction of the soils around camp areas has the potential to create water quality problems. Soil compaction can restrict or alter spring flow. It is suspected that bacterial pollution exists and contaminated water may be seeping back into the springs.

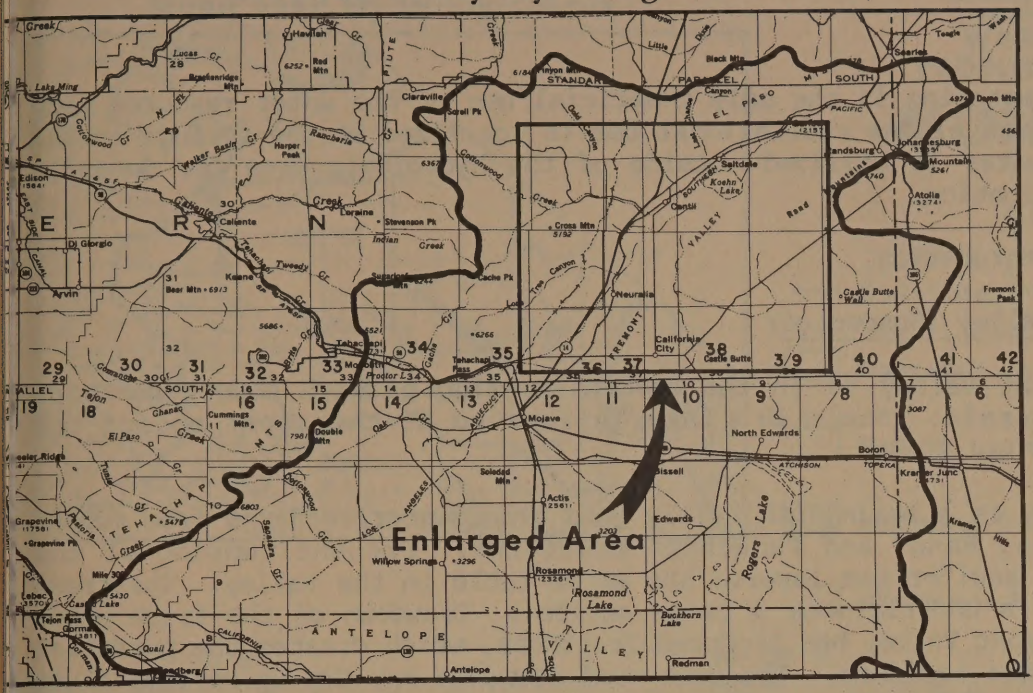
Effect On Beneficial Uses: The beneficial uses being affected by uncontrolled recreational use re wildlife habitat and recreation. Wildlife are prohibited from easy access to these water sources and are forced to use alternative, less dependable water sources. The hot springs support various forms of unique fauna, which may also be impacted.

Information Needs: The long term camping and sewage disposal practices should be monitored closely to determine the magnitude and extent of use. Water quality sampling is necessary to evaluate the effect of these uses on the water quality.

Fremont Valley Hydrologic Area

The Fremont Valley Hydrologic Area is located east of Bakersfield, California at the southern end of the Sierra Nevada. The El Paso Mountains are on the west side with California City to the southeast. BLM administered lands are scattered throughout the area with the only consolidated tract adjacent to Koehn Dry Lake. Koehn Dry Lake is a saline dry lake and is the major geographic feature in the valley. Runoff is intermittent and flows chiefly from the mountains. The major water source is groundwater and springs and wells which tap the various aquifers. Groundwater is relatively abundant in Fremont Valley but present extraction may be affecting water supplies. The Fremont Valley is a desert area with precipitation ranging from 5 to 8 inches annually. The principal economic activity in this area is mining of boron, cesium, lithium, potash, and soda ash.

Fremont Valley Hydrologic Area

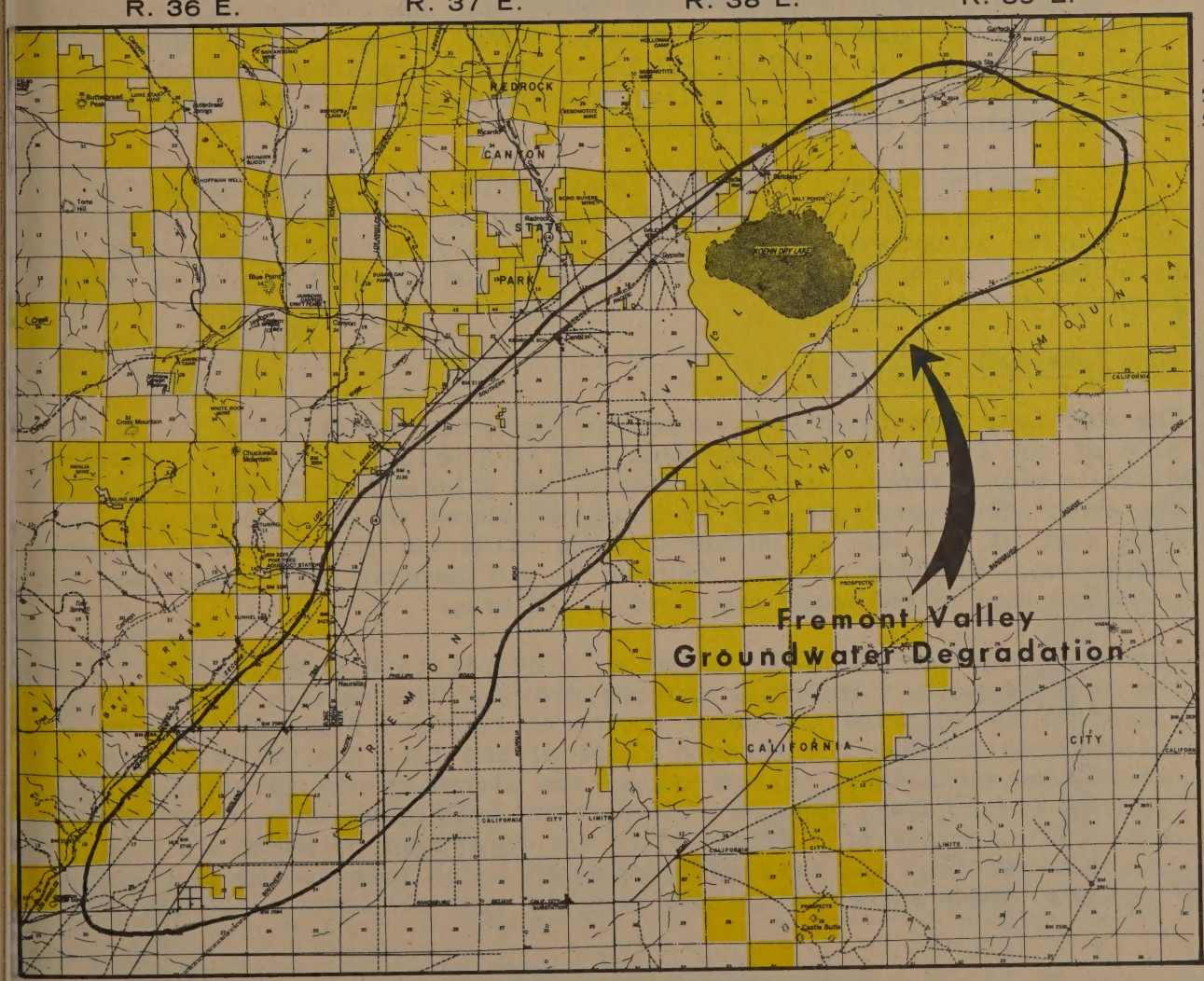


U.S. Bureau of Land Management
BAKERSFIELD DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

FREMONT VALLEY

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)



Mt. Diablo Base and Meridian

¼ Inch = 1 Mile

Figure 3-10

Wildlife watering is the only beneficial use of the water resource made by the BLM. Much of the recreational use is localized at the springs in the area. Groundwater is utilized outside of the hydrologic area for domestic supply and irrigation.

Ground Water Degradation

Fremont Valley (Suspected)

The Fremont Valley is in the eastern portion of Kern County north of Mojave, California. Koehn Dry Lake is located at the upper end of the valley.

The valley is a basin with fairly good groundwater recharge from runoff of the El Paso, Rand, and Tehachapi Mountains. Present pumping of the Fremont Valley aquifer has lowered the water table in the valley. The fresh water aquifer is underlain by a brine aquifer. Drawdown of the fresh water aquifer in Fremont Valley has produced fractures, which creates the potential for mixing of the aquifers. The continued drawdown may dry up springs along the valley perimeter. The springs in the area are vital to wildlife and provide a certain amount of recreational attraction.

Effect On Beneficial Uses: The beneficial use of the valley is for agricultural and domestic water supply. The springs in the surrounding mountains are used by wildlife and livestock and are a recreational attraction. Possible mixing of the valley aquifers would render the water useless as an agricultural and domestic supply.

Information Needs: A further investigation of fractures in the valley is needed, coupled with geological mapping of the surface to determine the aquifer structures. Water rights must be investigated since the only solution for excessive drawdown is readjudication of water rights or imposed pumping rate limitations.

Mono Lake Hydrologic Area

The Mono Lake Hydrologic Area is located along the Nevada border on the east side of the Sierra Nevada Mountains. It is a unique basin with historical geologic significance. Mono Lake area is the principal hydrologic feature in the area. The hydrologic area is comprised almost entirely of Federal land, with most of the BLM administered lands withdrawn for watershed resource protection. Wildlife habitat, recreation, and domestic water supply are the principal uses of the water resources in the area.

The area receives 12 to 50 inches of precipitation annually, mostly in the form of snow. Perennial streams draining the eastern slopes of the Sierra Nevada comprise the major source of runoff. Flows of much smaller volume originate on the western slope of the Inyo and White Mountains. Runoff from fresh water streams out of the Sierra Nevada mountains normally replenishes Mono Lake. However, water rights held by the city of Los Angeles under the authority of P.L. 864 allow the Department of Water and Power to divert water from the streams flowing into the lake to the Los Angeles Aqueduct. These water rights have priority over all beneficial uses of the

Mono Lake Hydrologic Area

U.S. Bureau of Land Management
BAKERSFIELD DISTRICT

WATER QUALITY PROBLEM ASSESSMENT

MONO LAKE

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands
- Watershed Protection Withdrawals

R. 26 E. R. 27 E. R. 28 E.

T. 3 N.
T. 2 N.
T. 1 N.

MONO LAKE

Mono Lake Diversion and Return Flow

Mt. Diablo Base and Meridian

½ Inch = 1 Mile

Figure 3-11

waters in the Mono Lake area under the present water rights laws. Mono Lake is the principal hydrologic feature of the area and is a closed basin saline lake which supports a substantial population of brine shrimp. The lake area provides habitat for various bird species and waterfowl. The brine shrimp are a critical food source for the various bird species and waterfowl which inhabit the Mono Lake islands and surrounding area.

Diversion and Return Flow

Mono Lake (Existing and Potential)

Mono Lake lies east of Yosemite on the east side of the Sierra Nevadas along the California-Nevada border. Mono Lake is approximately 55 miles northeast of Bishop, California adjacent to Highway 395 and presently covers 40,000 surface acres.

The volume of Mono Lake has decreased significantly during the past five years due to drought conditions, evaporation, and 100 percent diversion of replenishment streams. The volume reduction of Mono Lake has doubled the salinity concentration and increased alkalinity. Increases in carbonates and solubles occur as the volume of a lake is reduced. Alkalinity increases are detrimental to the development of phytoplankton and brine flies. These two links in the food chain are vital to the migratory and native bird populations which utilize the lake for habitat.

Effect On Beneficial Uses The continued reduction and subsequent salinity increases in Mono Lake will adversely affect the use of the lake as wildlife habitat. The rookeries of Negit and Pooba Islands would be impaired with any change in the food web of the lake's waters. Continued volume reduction in Mono Lake will form land bridges between the lake shore and Negit and Pooba Islands thus allowing predators to invade the presently safe rookeries.

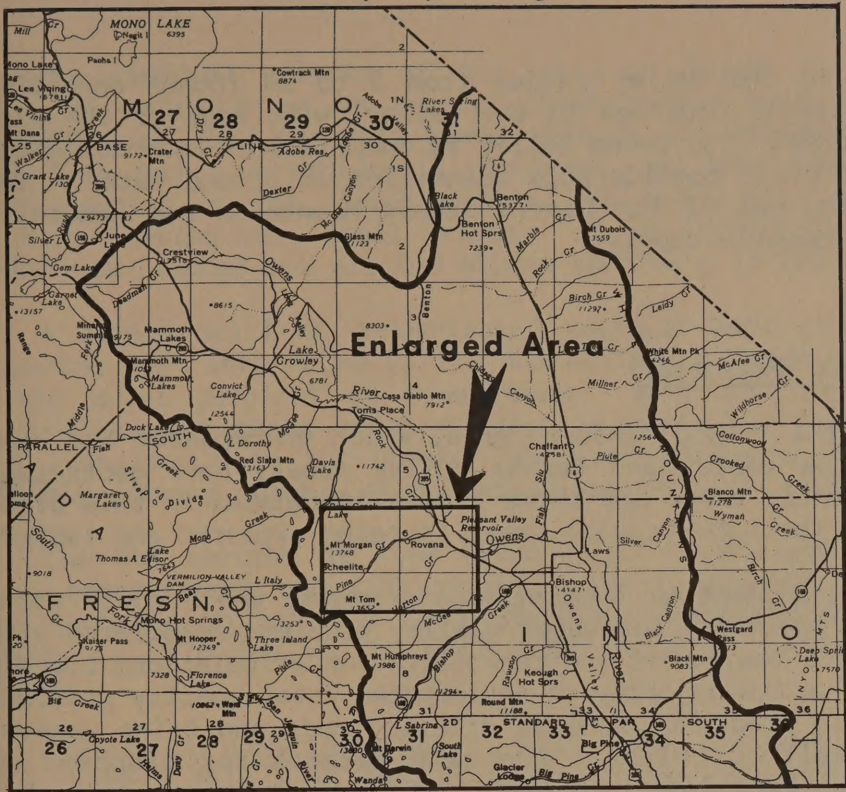
Information Needs: The water quality and quantity impacts of volume reduction in Mono Lake are complex and interrelated to the ecosystem of the lake itself. A continued study of bird populations and their dependency on the plant and animal populations of the lake is needed. A minimum flow requirement for inflow streams should be investigated since existing surveys and studies indicate a strong need for a stabilization of the lake volume.

Owens Valley Hydrologic Area

The Owens Valley hydrologic area is a long, narrow valley in eastern California starting north of Bishop, California and continuing south near Owens Lake. The valley water resources are allocated to the City of Los Angeles for water supply. The BLM administered lands, which comprise 40-50 percent of the valley, are withdrawn by the City of Los Angeles Department of Water and Power (LADWP). Activities occurring on BLM lands include recreation, mining, geothermal development and grazing.

The BLM beneficially uses the water resources of the valley for range management, wildlife habitat, and recreation.

Owens Valley Hydrologic Area

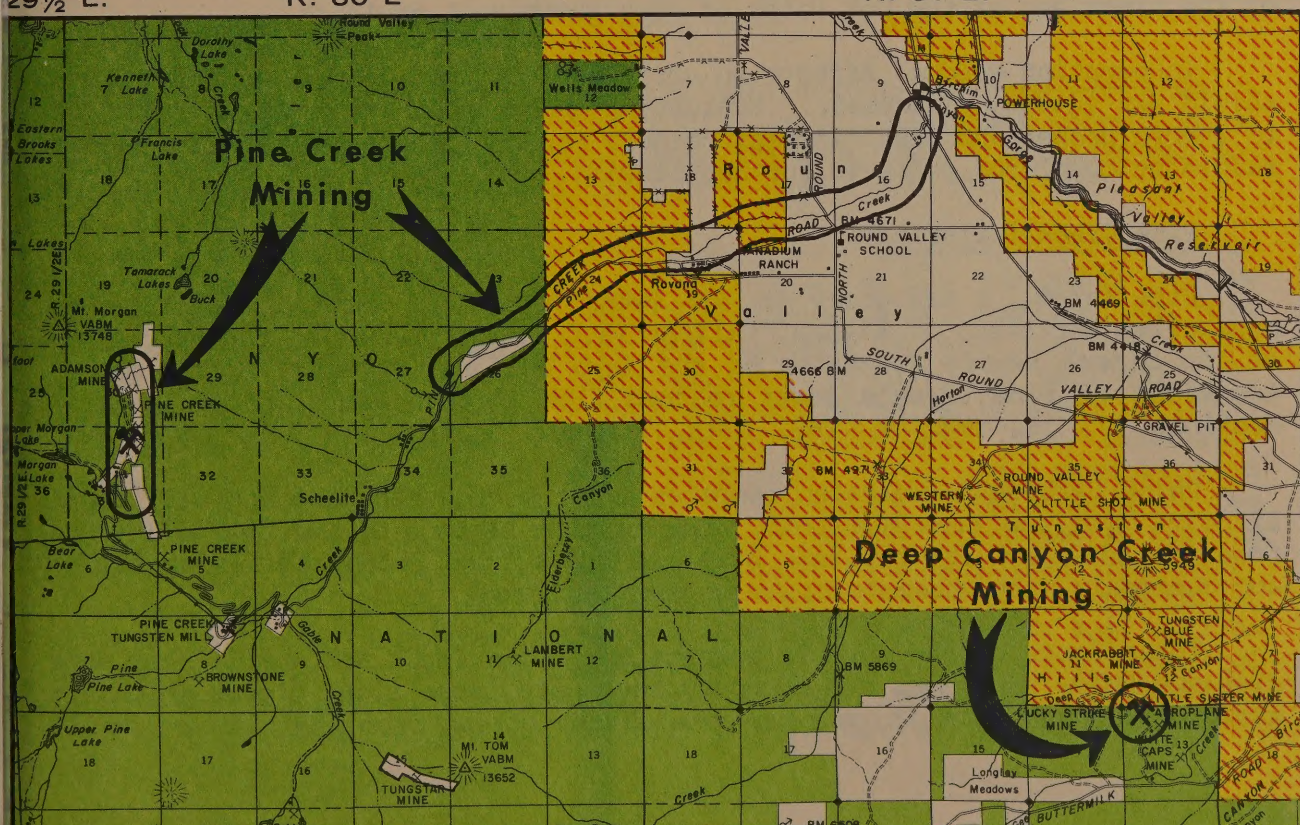


U.S. Bureau of Land Management
BAKERSFIELD DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

DEEP CANYON CREEK & PINE CREEK

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands
- Watershed Protection Withdrawals



Mt. Diablo Base and Meridian

½ Inch = 1 Mile

Figure 3-12

The precipitation in the valley ranges from 5 to 20 inches annually. The Owens River is the major drainage in the valley, with most of its flow being utilized by the LADWP. The Owens Valley is comprised of unconsolidated alluvial deposits which yield considerable quantities of ground water. The perennial streams flowing out of the Sierra Nevada Mountains are generally used for irrigation or domestic supply.

Mining

Bishop Resource Area (Potential)

Various places in the Bishop Resource Area, which encompasses the Mono Lake-Owens Valley, Saline Valley and Eureka Valley areas, have geothermal energy potential. Presently there are three leases designated in this area. One of these leases, in the Lake Crowley area, is being explored and tested.

Exploration and development of geothermal resources, which could occur in the future, have the potential for water quality problems associated with drilling. Present surface management and rehabilitation stipulations imposed by the BLM should mitigate the majority of anticipated water quality problems. Disposal of geothermal by-products, such as drilling muds and brine waters, could create water quality problems. Adequate methods for disposal of geothermal brines and drilling muds is critical since their extreme salinity and toxic elements pose a threat to surface waters and shallow aquifers.

Effect On Beneficial Uses: Geothermal development could affect the beneficial uses of surface waters and groundwaters if wastes are allowed to pollute these water resources. Polluted water has impacts on wildlife and recreation use of the area. Geothermal development also is a beneficial use of the steam and of the hot water of deep geothermal aquifers.

Information Needs: Affects on surface water from geothermal development should be closely assessed. Evaluation of geothermal lease stipulations to insure proper and best disposal methods for drilling muds and brine wastes should be completed prior to further leasing.

Pine Creek (Existing)

Pine Creek, a tributary to the Owens River, is located approximately nine miles northwest of Bishop, California. It originates on the east slope of the Sierra Nevada Mountains on the Inyo National Forest. Approximately two miles of Pine Creek's lower reaches flow through administered lands in Sections 17, 18, and 19, T6S, R31E, MDM and Section 24, T6S, R30E, MDM.

Union Carbide Corporation operates a large tungsten mine and mill about 11 miles upstream from BLM land. Due to pile seepage of various pollutants from the mill and its tailings pile and due to two recent spills of sludge and chemicals, the stream's fauna is very depleted.

The effects of the chronic seepage on public lands are small. For some distance below the upper BLM boundary there are large algal blooms which are a result of nutrients which have entered the stream from the mine and mill.

The residual effects of the spill on August 8, 1977 are also minor. The spill consisted of 300 tons of finely ground rock tailings wastes. Large quantities of this material moved through the BLM stream sections, killing some fish and invertebrates. Upstream, on USFS land, much of the sludge still remains in the slower waters, but below this the material has moved through, leaving only small traces. It is hoped that the heavy 1978 spring runoff has flushed out all the sludge remaining in the stream.

A second spill of concentrated sulfuric acid caused a large fish kill extending down into Round Valley and killing a large number of invertebrates in the upper portions of Pine Creek. With the compounded effect of the two spills, the fauna of Pine Creek is quite depleted. It is doubtful if many fish remain in the creek. The invertebrates, although hard hit, will probably recover quickly in BLM areas where little sludge remains.

The BLM section of Pine Creek above Rovana appears to receive fairly heavy recreational and fishing use. The California Department of Fish and Game normally stocks Pine Creek heavily although they did not stock in the summer of 1978 due to the poor condition of the stream from the recent spills.

Effects On Beneficial Uses: Pine Creek has been effectively eliminated as a fishery this past year because of the acid spills. The recreational use is impaired because of poor aesthetics of the creek resulting from leachates and algae growth.

Information Needs: Present information adequately depicts water quality problems. Efforts should be initiated to prevent future spills and restore Pine Creek to its normally healthy state.

Deep Canyon Creek (Existing)

Deep Canyon Creek is about four miles west of Bishop, California. The creek originates on the Inyo National Forest on the steep eastern slope of the Sierras. The BLM administered lands adjacent to Deep Canyon Creek are Sections 11 and 12, T7S, R31E, and Sections 6 and 7, T7Z, R32E, MDM.

The stream is heavily impacted by mining activities in the Deep Canyon Creek Watershed which are concentrated mainly along the Perennial section of the creek. In this area road crossings, placement and construction, port hole development, milling activities and tailings disposal all contribute heavily to the sediments and nutrients added to the stream by wind and water erosion. Sedimentation is the primary concern in terms of water quality. Disturbed soils are generated by the mining activities. They contribute trace metals and hazardous elements to runoff. Poor road construction procedures in the canyon, as exemplified by the Lucky Strike Mine where the road was built in the streambed, have created abnormal increases in erosion and sediment. The Little Sister Mine is situated on a spring and seep area. The water from the spring can be expected to leach hazardous elements out of the mine tailings. Improper culvert sizing and installation has lead to continued washouts contributing sediment to the creek. The steep slopes of the area help to naturally accelerate the erosion potential. This combined with the disturbed lands involved with mining operations significantly affects erosion rates.

Effect On Beneficial Uses: The Deep Canyon Creek is primarily a groundwater and subsurface recharge source for the Owens Valley and Owens River. Wildlife, as well as domestic livestock, utilize the water. The possible chemical pollution from spoil pile leachate is the primary beneficial use of Deep Canyon Creek.

Information Needs: The extent of chemical pollution should be determined.

Diversion And Return Flow

Owens Valley (Existing)

The entire Owens Valley has numerous streams and creeks originating in the mountains on Inyo National Forest land and flowing down into the Owens Valley. The majority of these water courses never reach the Owens River on the surface but are diverted or dissipate into the Owens River aquifer. Many of these water courses are diverted on BLM administered lands and used for agricultural irrigation or into the City of Los Angeles Department of Water and Power system.

These diversions disrupt the natural flow and recharge regime. Diversion ditches are often unmaintained or abandoned and promote unnatural levels of erosion. The majority of the diversions are not properly permitted by the BLM and are in trespass. The return flows from irrigation generally are of poorer quality and higher concentrations of dissolved solids. Generally the allocations for the water are properly filed water rights but the diversion is not a permitted right-of-way on BLM administered lands. These diversions destroy natural stream bank habitat, alter flow velocities, change water temperature, and often increase surface contact of the soil to water which increases erosion potential.

Effects On Beneficial Uses: The beneficial use of these waters for irrigation and water supply is augmented by these diversions. Diversions preclude the possible beneficial use of these waters for recreation, wildlife, groundwater recharge and fisheries.

Grazing

Marble Creek (Existing)

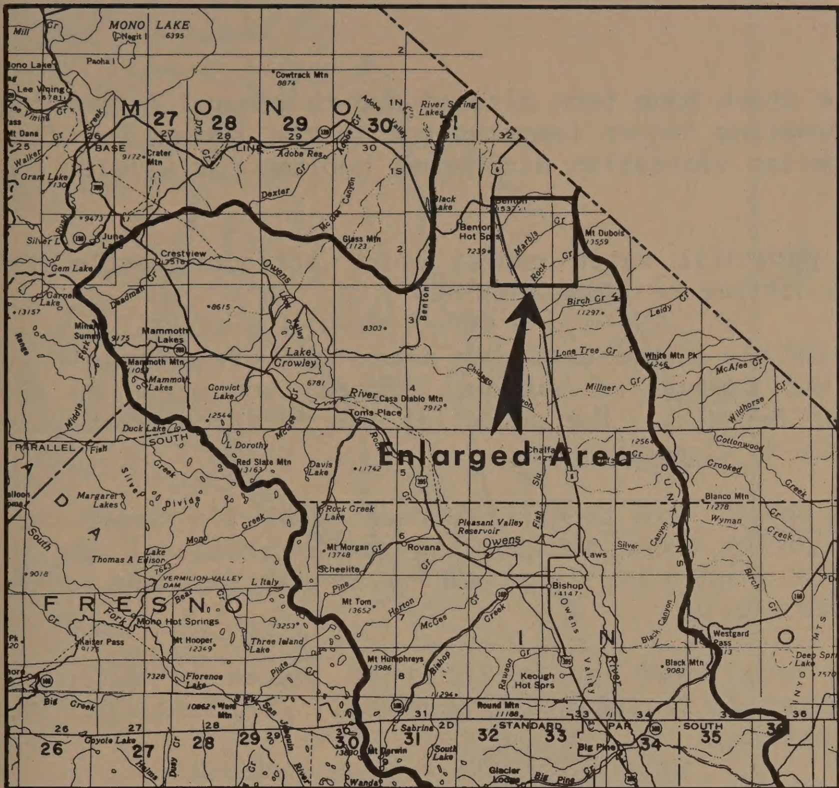
Marble Creek is in the northern portion of the upper Owens Valley along the Nevada border. Marble Creek flows southwesterly from its source in the White Mountains into Spring Canyon Creek and then into the Hammil Valley closed basin. The upper reaches of Marble Creek originate on the Inyo National Forest. For approximately 3.5 miles Marble Creek flows across BLM aministered lands in Sections 11, 14, 15, 21, 22, and 28 of T2S, R32E, MDM.

Marble Creek has been diverted into an artificial channel starting below the road crossing in the SE1/4 NW1/4, Section 14. The natural stream channel lies to the north of the man made channel. Portions of land along the channel have been burned to remove brush and riparian vegetation.

U.S. Bureau of Land Management
BAKERSFIELD DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

MARBLE CREEK

Owens Valley Hydrologic Area



LEGEND

Existing Problem Area

Patented Lands

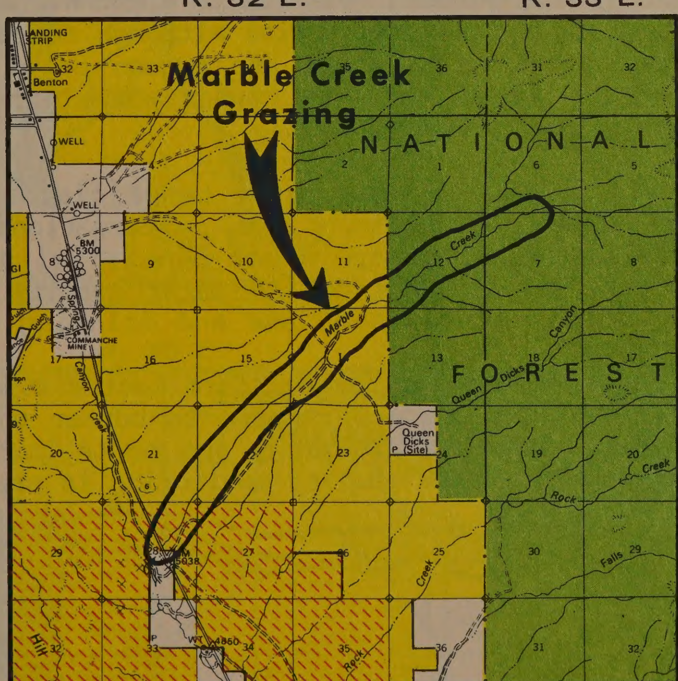
Public Lands (BLM)

National Forest Lands

Watershed Protection Withdrawals

R. 32 E. R. 33 E.

T. 1 S.



T. 2 S.

Mt. Diablo Base and Meridian ½ Inch = 1 Mile

Figure 3-13.

Temperature levels of the creek have been altered due to removal or burning of riparian vegetation creating higher temperatures in the summer low flow months. The lack of riparian vegetation diminishes habitat for wildife and fish.

Marble Creek is a perennial water course which attracts cattle and supports vegetative types desired by range cattle.

Heavy grazing and cattle concentrations along the creek result in stream bank sloughing, and removal of willows, sedges, and grass on the stream banks and adjacent benches. The potential for fecal coliform pollution exists and is likely to already exist.

Effect On Beneficial Uses: The beneficial uses of Marble Creek vary from livestock water, wildlife water and habitat and recreational use to agricultural purposes. The grazing use is affecting the use of these waters for recreation and wildlife habitat.

Information Needs: More water quality data is needed to determine the extent of any suspected fecal pollution problems. Sedimentation has been observed but not quantified.

Recreation

Benton Crossing (Existing)

Benton Crossing is adjacent to the Owens River directly north of Lake Crowley. The Benton Crossing area is BLM administered land withdrawn for watershed protection by the City of Los Angeles Department of Water and Power and is surrounded by the Inyo National Forest. The location of Benton Crossing is Section 10, T3S, R29E, MDM.

During the spring and summer, the Benton Crossing area is used extensively for camping and related recreation although no camping facilities are provided. Considerable recreational use occurs on or adjacent to the Owens River. The heavy use of the area causes above normal sedimentation and litter accumulation in the Owens River.

Effect On Beneficial Uses: The major beneficial use of the Owens River is reservoir supply for domestic use. Recreational fishing, fish habitat, wildlife and aesthetics are other beneficial uses. Bacterial pollution and sedimentation are critical to water quality in Lake Crowley and detrimentally affect recreational use and drinking water supplies.

Information Needs: Monitoring for coliform bacteria is needed as well as evaluation of recreational use and numbers to better understand management needs of the area. Possible mitigation may be to initiate more intensive recreation management. Water quality monitoring is presently occurring in Lake Crowley.

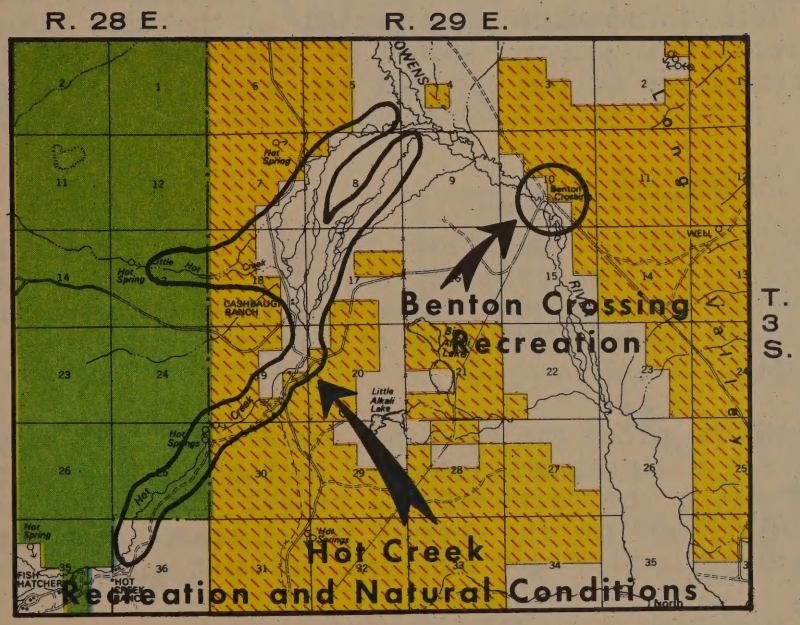
Owens Valley Hydrologic Area

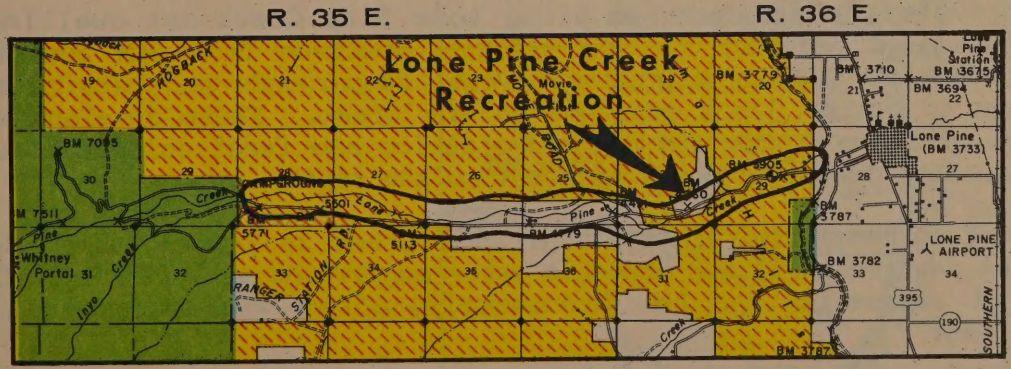
U.S. Bureau of Land Management
BAKERSFIELD DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

HOT CREEK & BENTON CROSSING & LONE PINE CREEK

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands
- Watershed Protection Withdrawals





Mt. Diablo Base and Meridian

½ Inch = 1 Mile

Figure 3-14

Hot Creek (Existing)

Hot Creek is north of Crowley Lake and is a tributary to the Owens River. It originates in Inyo National Forest and supplies water to the California Department of Fish and Game fish hatchery. Hot Creek flows across BLM administered lands in Section 19, T3S, R29E, MDM.

Sediments and excessive aquatic vegetation growth are problems in Hot Creek. The California Fish and Game, USGS and USFS are investigating the source of sedimentation. The probable cause is the natural geologic conditions of shallow, undeveloped soils and sparse vegetation. The nutrient outflow from the fish hatchery is likely to be contributing to the growth of aquatic vegetation. There is a large amount of recreational use in and along Hot Creek. Many people use the hot springs in and along the creek for bathing and soaking which results in a potential for bacterial pollution.

Effect On Beneficial Uses: Sedimentation and aquatic vegetation affect the fishery in Hot Creek. Recreational use of the hot springs is another beneficial use being impacted. Hot Creek supplies water, which may be impacted. Hot Creek supplies water, which may be impacted by bacterial pollution, to the Owens River-Lake Crowley water system which is used for agricultural and municipal water supply by the City of Los Angeles.

Information Needs: More information is needed to evaluate the source of sedimentation. This information is expected in the near future from USGS and USFS. A monitoring program should be initiated on BLM lands to determine if recreational use of the upstream hot springs is creating water quality problems.

Lone Pine Creek (Suspected)

Long Pine Creek is east of, and flows through, Lone Pine, California in the Owens Valley. The creek originates in the John Muir Wilderness on the eastern slope of the Sierras. Lone Pine Creek flows across four miles of BLM administered lands. The areas of concern are Sections 25, 26, and 29, T15S, R36E, MDM.

Heavy recreational use along the creek has resulted in soil compaction. Concentrated use on BLM administered lands in Section 29 have noticeably compacted the soils along the banks of the creek. The creek has been channelized to provide passage for the Whitney Portal road. Bank instabilities created by the channelization have increased sediment entering the lower section of the creek.

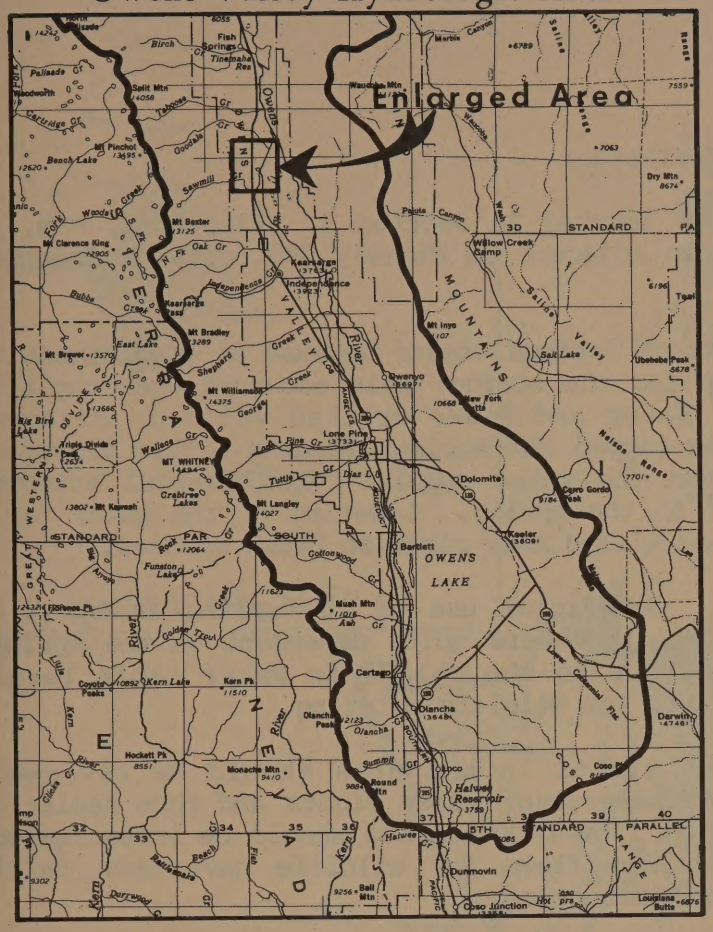
A privately owned section along Lone Pine Creek has dwellings and resort buildings adjacent to the creek. Upstream from BLM administered lands the Forest Service maintains several campgrounds and permits several businesses to occupy lands adjacent to the creek. These developments are suspected to be major sources of sedimentation and fecal coliform pollution due to improper sewage disposal adjacent to the creek.

Effect On Beneficial Uses: Lone Pine Creek is beneficially used for recreation, agricultural and domestic water supply and as a fishery. Concentration of recreation use can detrimentally affect the recreational value of the creek.

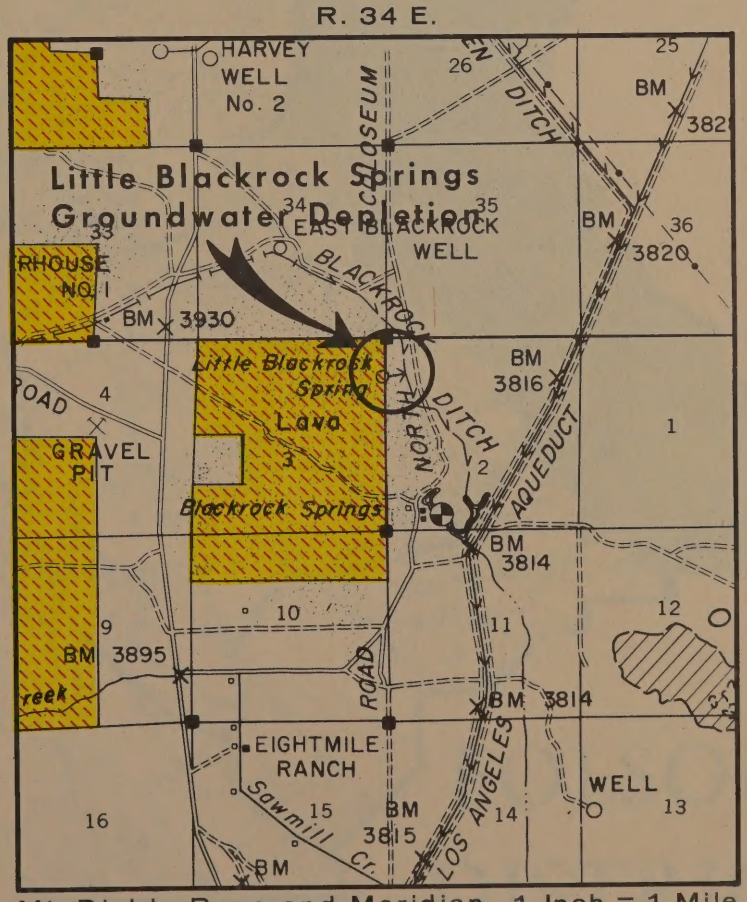
U.S. Bureau of Land Management
BAKERSFIELD DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

LITTLE BLACKROCK SPRINGS

Owens Valley Hydrologic Area



R. 34 E.



Mt. Diablo Base and Meridian 1 Inch = 1 Mile

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- Watershed Protection Withdrawal

Figure 3-15

Groundwater Depletion

Little Blackrock Springs (Existing)

Little Blackrock Springs is located in Section 3, T12S, R34E, MDM, in the Owens Valley. The spring is adjacent to Highway 395 north of Independence, California.

Flow from the Little Blackrock Springs ceased because of development of the groundwater resources which fed the spring; this occurred when the City of Los Angeles Department of Water and Power drilled wells on adjacent lands owned by them. The wells tapped the aquifer feeding Little Blackrock Springs and essentially depleted the water supply. Unsuccessful attempts have been made to return water to the spring. Lowering of the water table in the vicinity of the spring has killed many riparian brush species.

Effect On Beneficial Uses: Beneficial use of the spring is by wildlife and domestic livestock. Wildlife were quite dependent on the spring. The surrounding cover has died due to the change in water table levels and has made the spring undesirable for wildlife watering.

Information Needs: Water rights in the area should be reviewed. Little Blackrock Springs may not have prior water rights and thus depletion of the spring is legal. Instream flow requirements should be investigated. Present efforts to initiate minimum flows for wildlife have been fairly successful and might apply in this situation.

FOLSOM DISTRICT

Figure 3-16

FOLSOM DISTRICT

The Folsom District (Figure 3-16) is comprised of 25 counties, has 1/3 the population of the State, and occupies 21,888,000 ac (8,858,073 ha) of central California. The district manages 622,455 ac (251,908 ha) of extremely fragmented public land that fashions many unique and difficult management situations. Managed are 1,800 parcels of land ranging in size from 0.5 ac (0.2 ha) in Alameda County to a 30,000 ac (12,141 ha) block in San Benito County. A breakdown of BLM administered land ownership by county is given in Table 3-1.

For administrative purposes, the District is divided into three Resource Areas (Figure 3-1): Northern Motherlode, Bay Sierra, and Diablo.

Five State Water Quality Control Board (SWQCB) Planning Areas are partly within, and two are fully within, Folsom District boundaries. The ones partly within are: Sacramento River, Tulare Lake, Central Coastal, San Francisco Bay, and North Lahontan. The two fully within are: Sacramento - San Joaquin Delta and San Joaquin River.

In order to facilitate incorporating the Problem Assessment for the Folsom District into the SWQCB's Basin Plans, the Folsom District was divided into hydrologic areas which correspond to SWQCB Planning Areas. These are identical both in name and boundary (Figure 3-16). These hydrologic areas (which will be discussed later) include all the rivers on the west side of the Sierra Nevada from the Yuba in the north to the San Joaquin in the south. The only other major river affected by Folsom District administered land is the San Benito which is located in the southeast corner of the District.

It is important to note (especially from a hydrologic stand-point) that the BLM administers scattered parcels of land on its hydrologic areas. Thus, its management activities cannot have a significant effect on the hydrologic properties of a particular hydrologic area. At most, it can only be said that BLM administered land in the Folsom District can contribute pollutants to the major streams, but not adversely affect them.

Management Activities

The District emphasizes total multiple use resource management. This includes timber production, watershed protection, outdoor recreation, wildlife development and utilization, livestock grazing, minerals, industrial development, and orderly expansion of communities surrounded by federally owned land. Major emphasis is placed on outdoor recreation, timber production and watershed protection.

A brief synopsis of the district's active management follows. Detailed statistics are given in Table 3-20.

Recreation

The recreation program is geared toward meeting the demand for private and commercial ORV events, whitewater programs, hunting, fishing, hiking,

TABLE 3-1

FOLSOM DISTRICT
BLM Ownership by County

County	Total Acreage	BLM Acres	% of Total
Alameda	469,120	.5	
Alpine (2)	462,720	18,152	3.9
Amador	379,520	9,286	2.4
Calaveras	657,280	39,500	6.0
Contra Costa	469,760	539	.1
El Dorado	1,096,960	20,700	1.9
Fresno	3,816,960	129,000	3.4
Madera	1,372,160	7,700	.6
Mariposa	931,200	72,388	7.8
Merced	1,268,480	4,656	.4
Mono (1)(2)	230,400	22,508	9.8
Monterey	2,127,360	68,715	3.2
Nevada	625,920	19,544	3.1
Placer	911,360	21,414	2.3
Sacramento	629,120	38	
San Benito	893,440	128,130	14.3
San Francisco	28,800		
San Joaquin	901,760		
San Mateo	290,560	25	
Santa Clara	833,280	7,564	.9
Santa Cruz	280,960	204	.1
Stanislaus	960,000	6,136	.6
Sutter	388,480	160	
Tuolumne	1,455,360	47,352	3.2
Yuba	407,680	3,410	.8
Total	21,888,640	622,455	

(1) Only part of the county is within Folsom District

(2) Administered by Carson City District

Table 3-2

FOLSOM DISTRICT STATISTICS

(as of Jan. 1978)

1. General		
A. Total acreage, public and private, within external boundaries of the District		21,888,640
B. Total BLM acreage		622,455
1. Acreage of rangeland		331,654
2. Acreage of productive forestland before applying restrictions		67,400
3. Estimated productive forestland after applying restrictions		25,000
4. Acreage of woodland		173,000
5. Miles of perimeter (external boundary of District)		950
6. Miscellaneous		25,401
C. Roads (miles programmed and/or built by BLM)		870
D. Topography (percent of area which varies in elevation more than 3,000 feet)		10
E. Number of mining claims		60,000 +
F. Total number of trespass cases dealt with annually		280
1. Grazing		5
2. Occupancy	Approximately 1,000 on hand. Only process 5-6 per year due to manpower.	
3. Timber		30
G. Number of recreation visits annually		500,000 +

Table 3-2 (continued)

H. Population increase trends (average annual percentage) 4.7

I. Average number of land-use applications annually:

1. R.U.P.'s 45
2. Oil and Gas lease 125
3. Other 32

J. Average number of land-use investigations 300

K. Brief description of land pattern: Scattered blocks and parcels in areas of extreme land-use pressures

L. Brief description of fire hazard (number of fires annually, etc): Extremely hazardous fire conditions prevail during the summer and all months. Temperatures are high, winds are continuous, and rainfall slight to none. Fuels are critically dried. The heavy valley population pressures cause extensive use of BLM lands and compound the fire hazard.

1. Number of fires annually 26

(a) Man-caused 32
(b) Lightening 6
(c) Miscellaneous 5

2. Fire protection is contracted with USFS and CDF

camping, and dredging for gold. One of the largest whitewater programs in the United States is administered by the Folsom District. The South Fork of the American, Mokelumne, Stanislaus, Merced, Tuolumne Rivers and the South Fork of the American Rivers are heavily used during the summer season for water based recreational pursuits. Recreation has probably had the greatest impact upon the district in recent years with 500,000 visits per year and has resulted in district-wide water quality concerns. BLM land alongside Sierra eastside streams is ideal for camping and day use activities. Concentrations of campers, day users and ORVs can result in trampling of vegetation, soil compaction, and decreased infiltration rates - all of which contribute to increased erosion. Also associated with camping is the likelihood of sanitary and solid waste refuse which leads to bacterial, nutrient, and BOD contamination of waters.

The Sierra eastside streams are used for municipal water supplies, agriculture, recreation, fish habitat, and spawning, and wildlife habitat. Large amounts of sediment and BOD would be required before fish habitat, and spawning areas and wildlife habitats are impacted. The greatest threat of pollution is to municipal water supply and contact recreation from coliform bacteria and nutrients which can exceed recommended limits.

Even though some water quality data is available, sampling is needed both above and below BLM administered lands so the contributions of pollutants actually coming from these lands can be accurately evaluated. Sampling should focus on gathering data on total and fecal coliform bacteria, fecal streptococci bacteria, nitrogen, phosphorous and suspended sediment.

Wildlife

Due to the diversity of lands within the district, habitat for many species of wildlife is provided. The improvement of springs, the development of watering facilities, and cooperation with California Department of Fish and Game are essential elements.

Silviculture

The forest management program enables the district to sell several million board feet of timber per year. Primarily the mature, diseased and defective trees are removed. The young, vigorous growing stands are left for future use. There will be some thinning of these stands where necessary for improved growth.

Productive forest land totals 67,000 ac (27,115 ha) with a standing volume of 809 million board feet. With intensive forest management, Folsom District's forest stands could produce over 300 million board feet every 100 years with an estimated value of $10 million.

Silviculture related activities on the Folsom District are suspected to be causing water quality concerns. Timber harvest throughout the Folsom District may be affecting beneficial uses of the waters along Sierra eastside streams. The activity has taken place, is taking place, or will take place on almost all BLM administered land where commercial conifers exist. Tractor logging is used primarily, however, cable logging methods are beginning to be used.

The most serious suspected problem due to mining is mine drainage generated by oxidation of pyritic materials with air in the presence of water. This drainage is an acidic mixture of iron salts, other toxic metals (copper, zinc, arsenic, lead) and sulfuric acid. The mine drainage arises from both underground and surface mining sources and is flushed into nearby water courses as "slugs" during storms.

The mining activities have a pronounced effect on groundwater supplies. Alteration of groundwater distribution patterns results in aquifers contamination from disturbed bedrock formations which permit mixing of contaminated with good water. Also, mine drainage can enter groundwater bodies by percolating through porous media.

Water quality data obtained from routine analysis can be related to the source of contaminants which may be found in the sample. A check for anion-cation balance in water samples would be very useful to assure that all chemicals (and possible contaminants) have been tested for. If contaminants characteristic of a mine are found, a sampling scheme can be set up to "single out" a possible source. By obtaining data in a manner as to bracket both surface and groundwaters affected by a mine, the impact from a particular mine can be properly evaluated.

Lands

A large and diverse lands program exists in the district. The casework load involves 13 different types of lands cases, many being public demand cases.

There is a backlog of 1,000 known and suspected trespass cases of all types. Of these, 600 are occupancy cases, most of which are connected with mining claims. Other trespass problems involve transients and their associated abandoned vehicles, theft, garbage, drugs and poor sanitation.

Special Programs of Current Interest

During the past three years, the Folsom District has participated in the preparation of study reports and draft environmental impact statements to determine whether the Tuolumne, and north fork of the American Rivers should be included in the National Wild and Scenic Rivers System.

Wild horses, which were originally obtained from the Carson City and Battle Mountain Districts, have been recently relocated. The relocation process involves investigative work, contacts with former and prospective owners, veterinarians, SPCA, news media, transportation of horses to the district`s local distribution center and answering letters from concerned citizens. It appears that the wild horse workload will increase in future years. Also, a small herd of wild burros is managed within the district.

Sacramento Hydrologic Area

The Sacramento River Basin (Figure 3-16), 26,500 sq mi(68,635 sq km) in area, encompasses the drainage of California's largest river. Water from the westerly drainage of the Sierra Nevada and Cascade Mountains, easterly drainage of the Coast Ranges, and the valley floor, supplies all the drain-

age which averages 21,200,000 acre-feet (2.6 X 10^{10} m^3) per year. Sub-basins to the Sacramento River within the Folsom District are the American, Yuba, and Bear River Basins. The counties within these basins having BLM land are Yuba, Nevada, Placer, and El Dorado. The percentage of BLM lands within these counties is given in Table VI-1. Figure IV-2 shows BLM land status.

Mineral quality of those waters under BLM management and administered by the Folsom District is excellent. Total dissolved solids and chloride concentration are minimal and hardness is low. Water quality has been fairly uniform year round, however, increasing concentrations of nutrients have been noted, particulary in Folsom Lake.

The climate of the valley floor and lower foothills consist of two seasons characterized by hot summers and mild winters. Mean seasonal precipitation is 23 in (58.4 cm) and decreases from north to south. Average temperatures range from 44°F (6.6°C) in January to 80°(26.6°C) in July.

In the mountains to the east and north of the valley floor, an alpine climate prevails characterized by short summers, cold winters, and a three-month frost-free period. At elevations above 5,000 ft (1524 m), nearly all precipitation occurs as snow.

Wildlife habitat and plant community distribution is varied on BLM adminstered land within the Sacramento River Basin. Coniferous and hardwood forest and grasslands are found above the valley floor and in the mountains. Warm and cold water fisheries support trout, bass, blue gill, and anadromous fishes such as King and silver salmon, shad, striped bass and steelhead. Dominant wildlife include deer, wild boar and band tail pigeon, turkey, doves, and quail.

Beneficial uses of the waters in the Sacramento River Basin are many. These include municipal and domestic supply, irrigation, stock watering, industrial, contact and noncontact recreation, warm and cold water habitat, wildlife habitat, spawning, and navigation. The BLM uses the waters for recreation, and fish and wildlife habitat.

Major BLM management activities in this basin are timber harvest, recreation, wildlife management, livestock grazing, minerals, and watershed protection. Several management activities lead to water quality concerns - mining, recreation and silviculture.

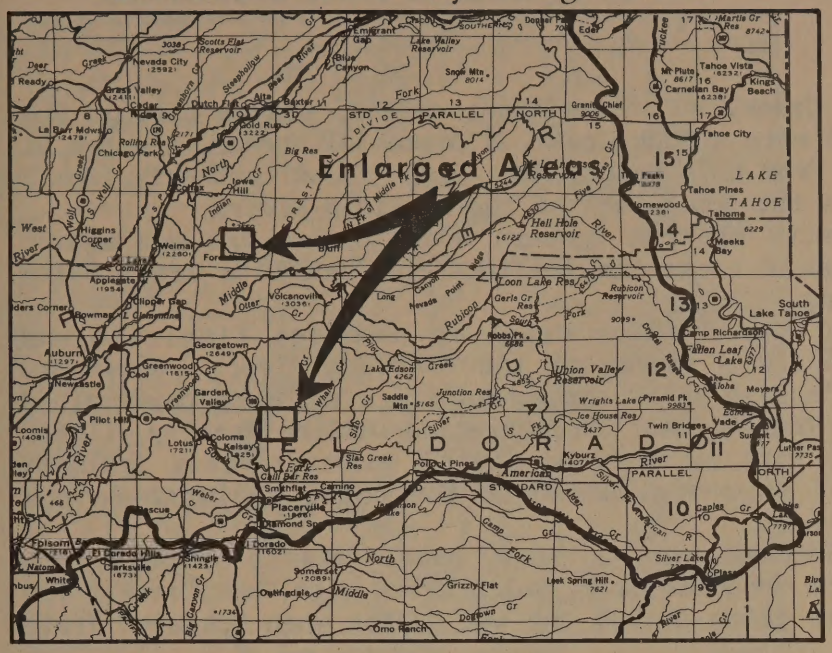
Mining

Mining concerns in the Sacramento River Basin involve open pit, underground, and suction dredge mining. The mines are either active or inactive.

Alhambra Shumway (Existing)

This inactive underground gold mine, located in T11N, R11E, sec 6, SE 1/4, MDM., is on patented land (figure 3-17) but is immediately surrounded by BLM land. Sediment from a tailings pile approximately 40,000 cu ft (1133 m^3) in volume, is being eroded into Mosquito Trail Gulch Creek and carried into Rock Creek.

Sacramento River Hydrologic Area



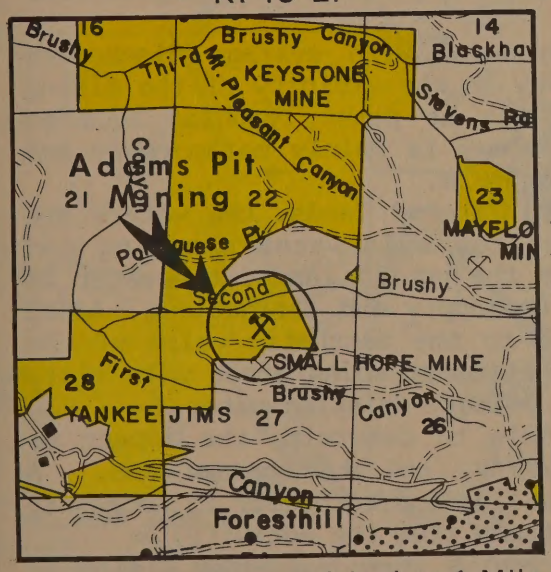
U.S. Bureau of Land Management
FOLSOM DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

ALHAMBRA SHUMWAY MINE & ADAMS PIT

LEGEND

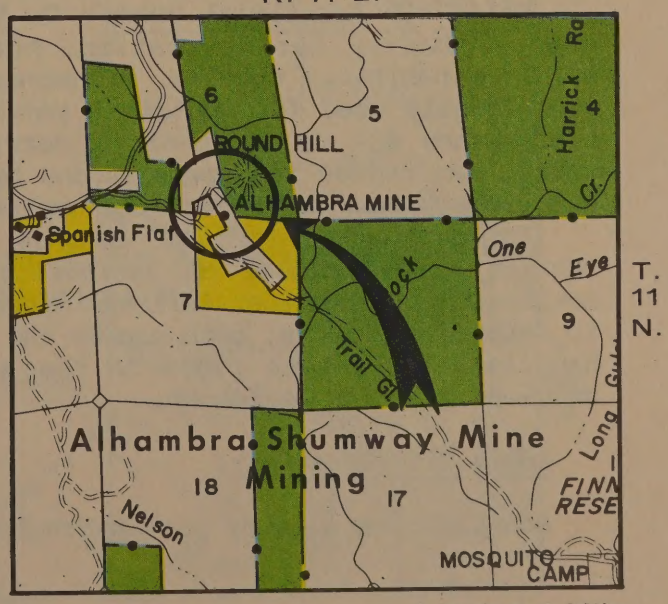
- Existing Problem Area
- Potential Problem Area
- Patented Lands
- Public lands (BLM)
- National Forest Lands

R. 10 E.



1 Inch = 1 Mile

R. 11 E.



1 Inch = 1 Mile

Mt. Diablo Base and Meridian

Figure 3-17

Mosquito Trail Gulch Creek, an intermittent stream, passes through BLM in T11N, R11E, sec. 7 and enters Rock Creek, a perennial stream, about 1 mi (1.6 km) from the mine. From this point, Rock Creek flows southerly from 3 mi (4.8 km) where it meets the South Fork of the American River.

The most notable effects of this concern occur during the wet season when precipitation and runoff erode the tailings into Mosquito Trail Gulch at which time it is flowing.

Effect On Beneficial Uses: Rock Creek is used for fisheries and wildlife habitat and also is a source of the American River. Sediments from the mine can result in fish kills throughout the creek from physical as well as chemical causes. The sediment concentration will be greatly diluted when it enters the South Fork of American River. However, this sediment must still be thought of as contributing to the total sediment in the American River.

Information Needs: Sediment, pH, an heavy metal data is needed before and after the confluence of Mosquito Trail Gulch Creek with Rock Creek. The sampling will have to take place during the wet season when Mosquito Trail Gulch Creek is flowing.

Suction Dredge Mining (Potential)

Suction dredge mining is being conducted for both commercial and recreational interests. The most popular rivers for this activity include the American, and Yuba. These rivers are generally mined in the foothill areas above the valley floor and below the rapid waters of the upper watersheds. Increases in sediment and turbidity result from suction dredge mining.

Suction dredge mining does not contribute any additional sediment to the channel. The process simply excavates and then re-deposits existing mine gravels downstream. However on a large scale, the process has the potential for affecting beneficial use.

The aforementioned rivers are all perennial with average discharges ranging from 600 cfs (16.9 cms). Topography in the vicinity of the mining activity is made up of low rolling foothills to peaks reaching 5000 ft (1524 m) in elevation. The underlying geology is mainly metamorphic and igneous rock with the river channels being gravels.

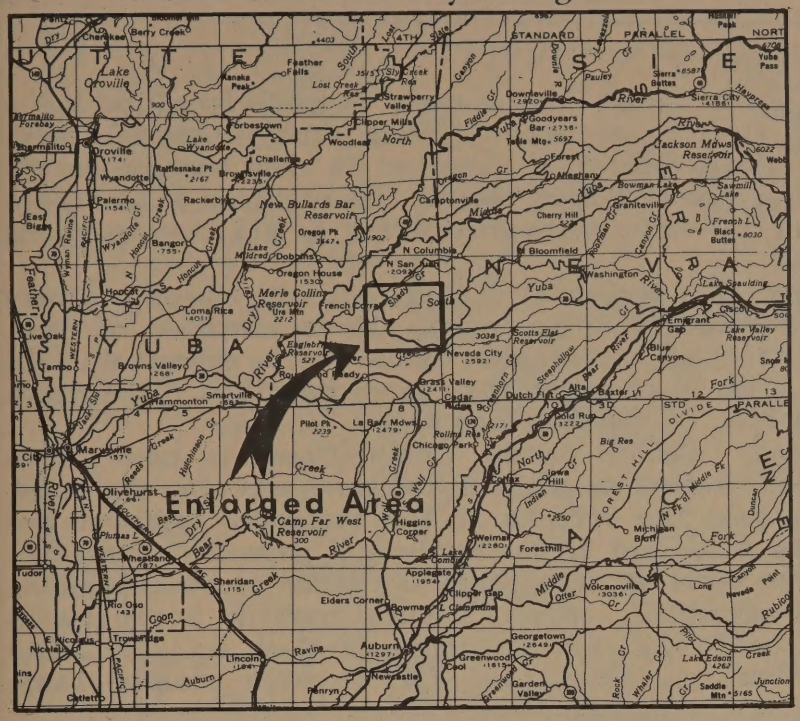
Effect On Beneficial Uses: On BLM administered lands, the waters are used primarily for recreation, but, also for cold water spawning and wildlife habitat. However, downstream from the public lands, the water is additionally used for municipal and domestic supply and irrigation. Added disturbance due to sediment is detrimental to the aesthetic value of the water, can reduce fish populations by blanketing spawning areas with silt, clog reservoirs, and reduce the quality for primary drinking water.

Information Needs: No data is available to determine the impact of suction dredge mining on aesthetics, spawning, and downstream uses. A monitoring program that reflects suspended solids and turbidity is necessary to determine effects, both nearby and downstream from the activity. Sampling should take place in the autumn months when hydraulic mining is heaviest and flow is lowest.

Adams Pit (Existing)

Adams Pit, a site of past hydraulic mining activity, is located in T14N,

Sacramento River Hydrologic Area



U.S. Bureau of Land Management
FOLSOM DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

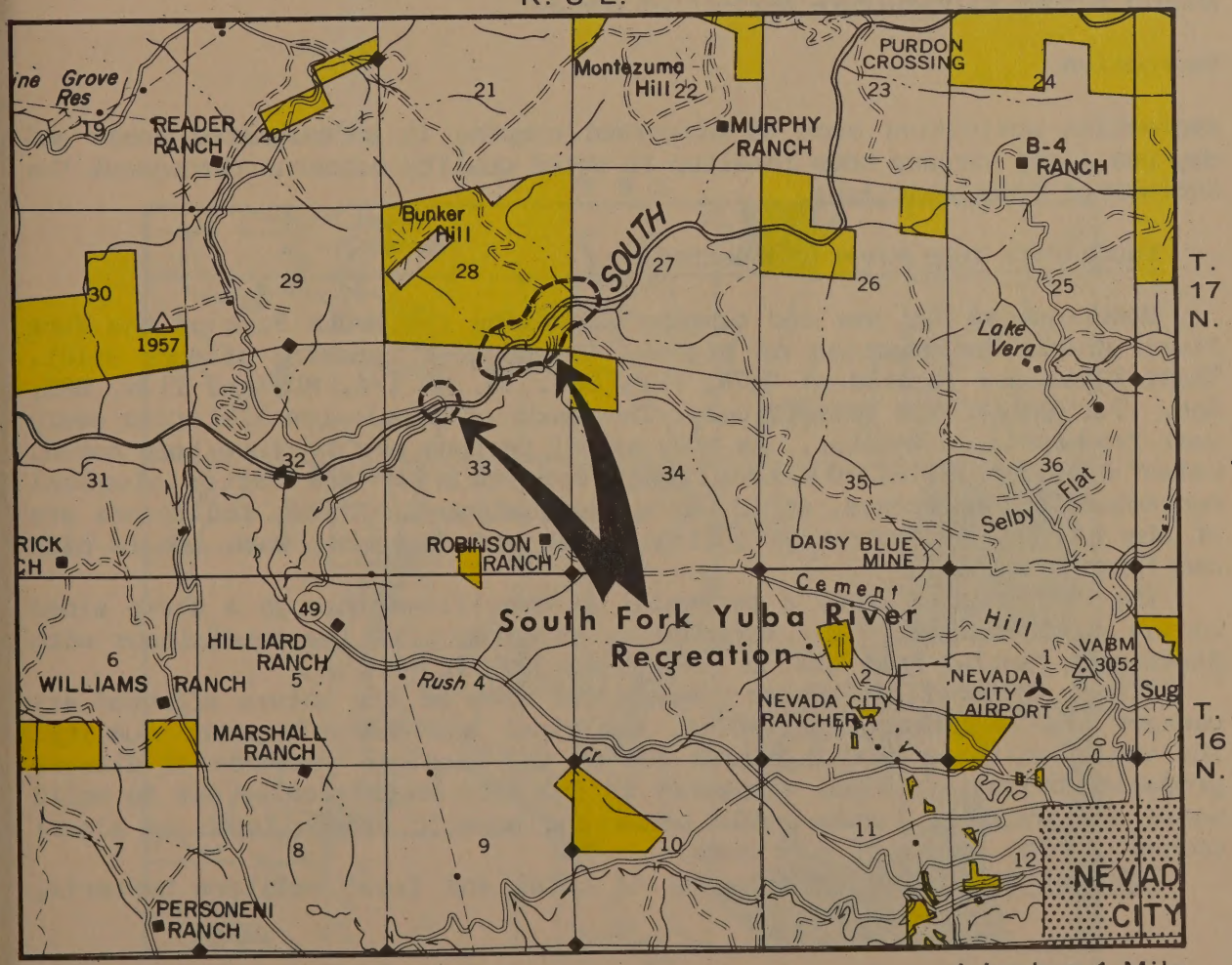
SOUTH FORK YUBA RIVER

LEGEND

Suspected Problem Area

Patented Lands

Public Lands (BLM)



Mt. Diablo Base and Meridian

1 Inch = 1 Mile

Figure 3-18

R10E, Sec. 22, 27, MDM (figure IV-16). The mine is positioned behind a ridge which is about 1000 ft (305 m) above Second Brushy Canyon Creek. Diverted water used in the mining operation resulted in mass wastage on the steep slopes adjacent to the creek. Even though the previous slides have somewhat stabilized, much of the mass wastage material is still exposed and poses a threat to the creek.

Second Brushy Canyon Creek is a perennial stream that cuts through a very steep sided canyon of approximately 100 percent slopes composed of well weathered rock. This combination makes the canyon very susceptable to slides and any disturbance greatly enhances this susceptability. The creek is a tributary of the North Fork of the American River.

Effect On Beneficial Uses: Second Brushy Canyon Creek is used for a fresh water habitat for trout. Large amounts of sediment entering the creek can cause fish kills both from the affects of the suspended sediment and any toxic metals that may be dissolved in the water. A potential threat to the water exists from the possibility of a large magnitude storm triggering a slide from the exposed material. Also, future logging activity is proposed that would take place in the area of concern. Such activity would definitely result in mass wastage, sheet, and rill erosion whereby large amounts of sediment will enter the water.

Information Needs: No water quality data is available on Second Brushy Canyon Creek. A monitoring program is needed for measuring suspended sediment during runoff events varying in intensity and duration. Also, monitoring would provide baseline data which can be used for comparison should future silviculture activities occur.

Recreation

Recreation activities such as dispersed camping in undesignated areas and day use along streams have resulted in water quality concerns throughout the Sacramento Hydrologic Area.

South Fork Yuba River (Suspected)

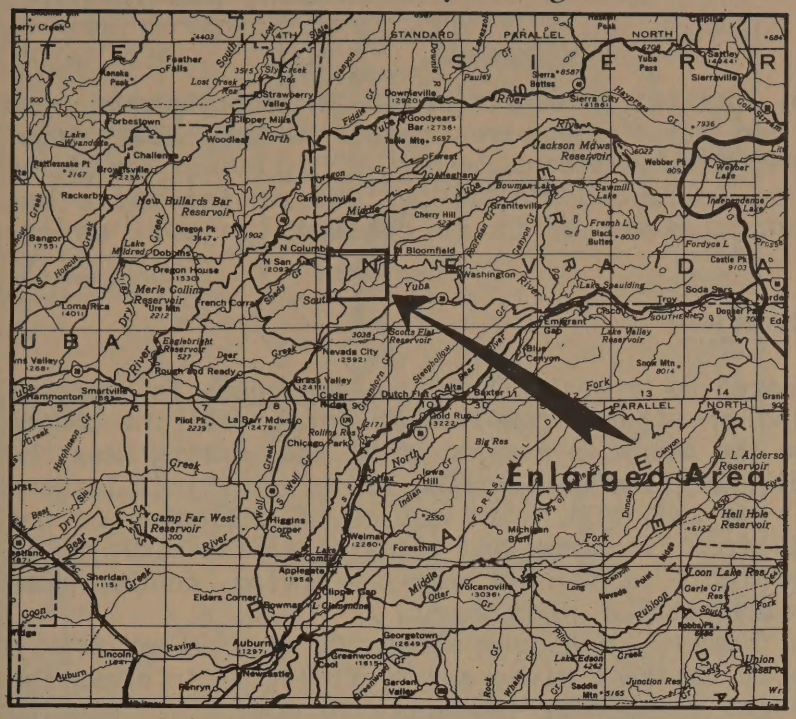
Undesignated day use and camping occurs on the South Fork of the Yuba River at the intersection of Highway 49 and Hoyt crossing (figure 3-18). These sites are located at T17N, R8E, Sec. 33, NW 1/4, MDM and T17N, R8E, Sec. 28, SW 1/4, MDM respectively. Thousands of people use the areas every year from April to October. As many as 300 persons per day have been noted. Water quality pollutants resulting from activity are bacteriological contamination, nutrients, solid waste, and sediment. These pollutants are at the highest concentration during August and September when use is high and flows are low.

The South Yuba River, a perennial stream, flows through a steep sided canyon in this area. The surrounding topography is low mountainous with elevations ranging from 1000 ft (305 m) to 3000 ft (914 m).

Effect On Beneficial Uses: Beneficial uses of the waters affected are contact and noncontact recreation, municipal and domestic water quality. The water may be a health hazard due to the possible presence of disease producing bacteria. Also, the water is degraded aesthetically due to solid waste and possible undesirable odors and aquatic growth (such as algae) caused by high levels of nutrients.

Information Needs: Monitoring of total and fecal coliform bacteria,

Sacramento River Hydrologic Area

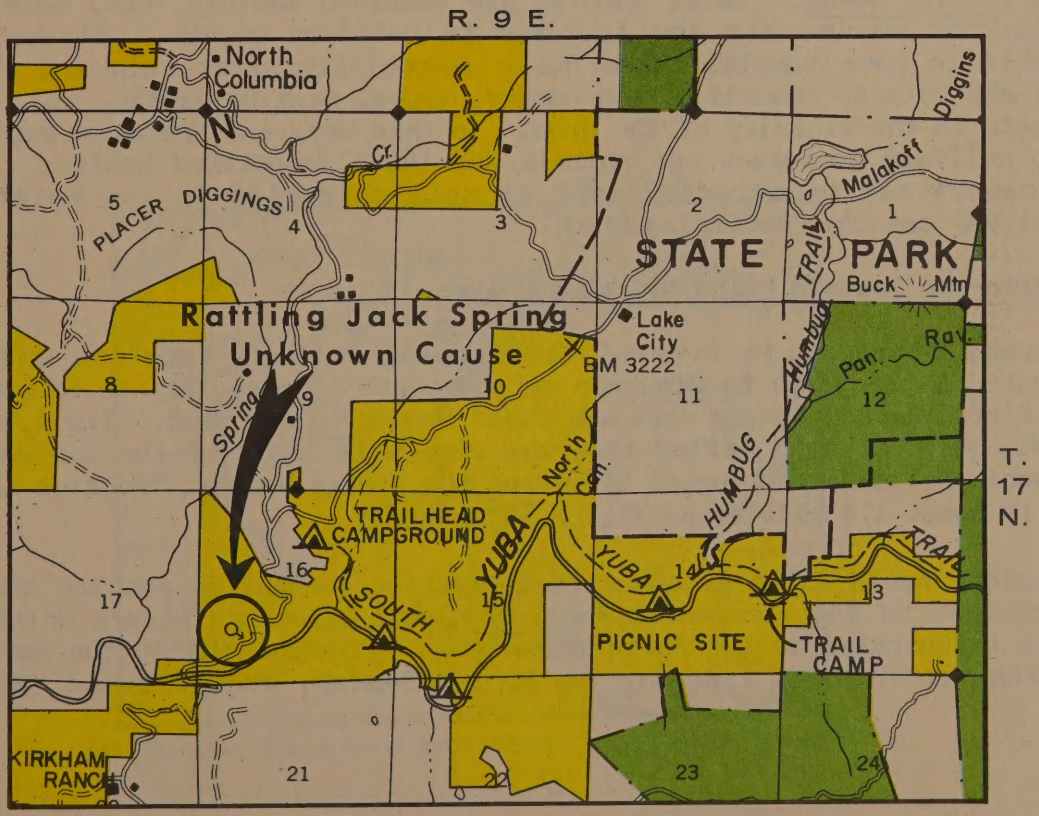


U.S. Bureau of Land Management
FOLSOM DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

RATTLING JACK SPRING

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands



Mt. Diablo Base and Meridian

1 Inch = 1 Mile

Figure 3-19

fecal streptococci bacteria, nutrient levels (nitrogen and phosphorous), and suspended sediment before and after the river passes through BLM administered lands would indicate if significant levels of pollution are being generated. Data should be collected during periods of intensive use and low flows (such as late summer) so as to reflect the most severe impacts.

Rattling Jack Spring (Existing)

This spring has been posted as a health hazard. The cause is unknown, but most likely from grazing or natural conditions. Total coliform counts have been periodically above the acceptable standard in this spring near the BLM's south Yuba campground. Rattling Jack Spring (figure 3-19) is located in the T17N, R9E, Sec. 16, NW 1/4, MDM. The source of pollution is not certain, but, is most likely from livestock and wildlife in the vicinity of the spring. Since the water table is shallow near the spring, contaminants can enter the water, especially after a storm event.

Rattling Jack Spring is located in a draw about 300 ft. (91 m) from a tributary to the South Fork of the Yuba River and 40 ft (12 m) in elevation above the drainage. The local topography is gently to moderately sloping with elevations from 200 ft (61 m) to 2700 ft (823 m). Permeable soils overlying impervious sloping bedrock outcrops above the water table result in numerous springs in the area.

The spring empties into a collection box, maintained by the BLM, for the purpose of storage and easy access to the water.

Effect On Beneficial Uses: Rattling Jack Spring is a source of drinking water for day users and campers. Total coliform counts in excess of the acceptable limit (MPN less then 2.2) is the reason for posting the spring as to a health hazard and the collection box being removed.

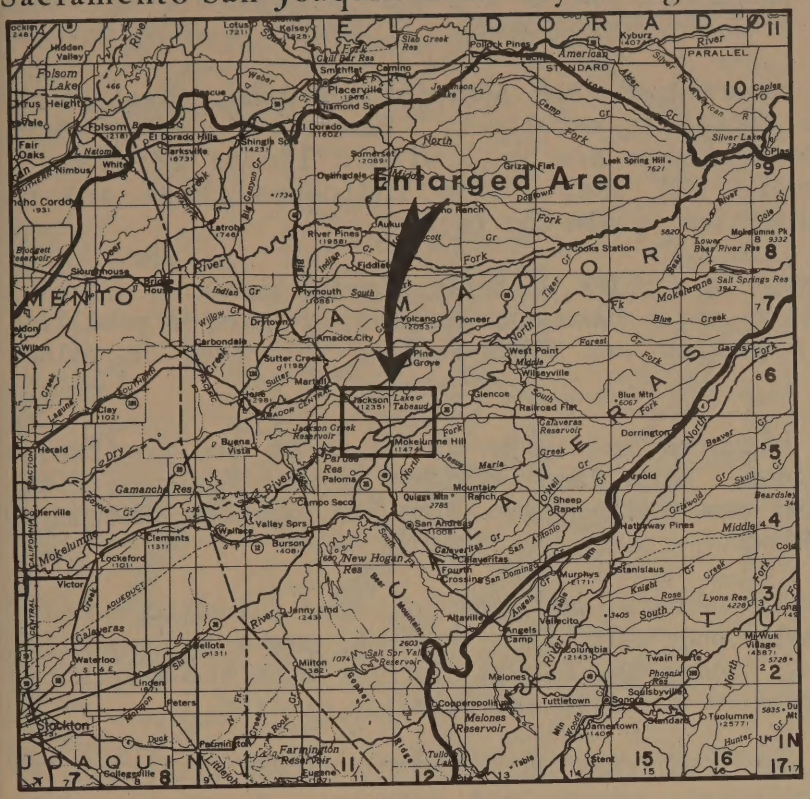
Information Needs: Water samples are obtained monthly, but, more data is needed to account for the increase in coliform counts. It would be preferable to have samples taken daily (especially after rain and runoff events) and to keep records of the number, types, grazing habits, and travel of animals in the vicinity of the draw. In this way, a correlation may show between coliform increases and animals and their associated habits. Also, other causes may be detected such as soil particles in the water. A rational BMP can then be implemented.

Sacramento-San Joaquin Delta Hydrologic Area

This area, situated in central California, extends from the city of Sacramento on the north to Stockton on the south (Figure 1). It is bounded by the Sierra Nevada on the east and Coast Ranges on the west. Its 4,947 sq mi (12813 km^2) of land varies from the flat tule lands of the Sacramento-San Joaquin Delta to the rugged slopes of the Sierra Nevada. Average annual runoff is about 1.4 million af (1.7×10^9 m^3).

The complete basin falls within Folsom District boundaries and the BLM has land adjacent to the Consumnes, Mokelumne, and Calaveras Rivers which are the main tributaries to the Delta (Figure 2). Counties within the basin in which BLM administers land are Amador, Calveras, and Tuolumne (Figure 3-1).

Sacramento-San Joaquin Delta Hydrologic Area

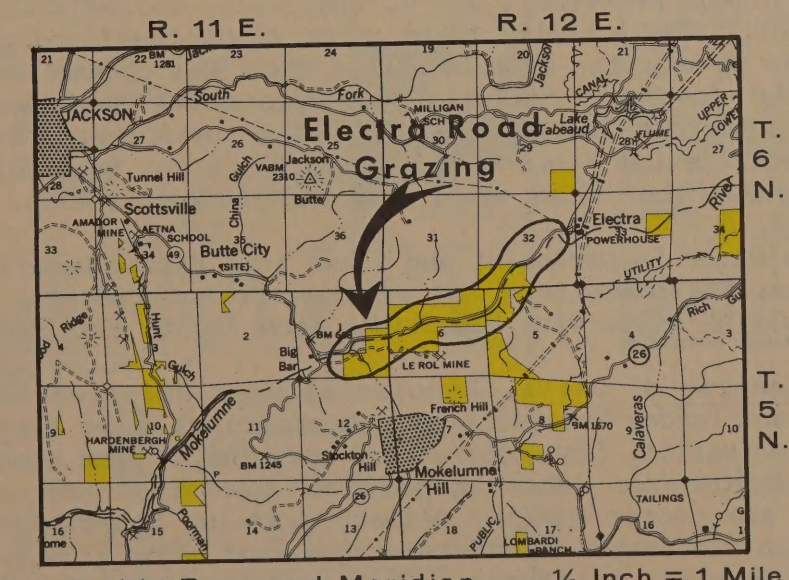


U.S. Bureau of Land Management
FOLSOM DISTRICT
WATER QUALITY PROBLEM ASSESSMENT

ELECTRA ROAD

LEGEND

- Potential Problem Area
- Patented Lands
- Public Lands (BLM)



Mt. Diablo Base and Meridian ½ Inch = 1 Mile

Figure 3-20

Water quality on streams adjacent to BLM administered land (Sierra side streams from foothills to Delta) is excellent. Electrical conductivity, chloride and boron concentrations are well within limits of class 1 irrigation waters and municipal use. This indicates there are no significant sources of degradation within the region.

Geologically, the basin floor is a thick westerly dipping wedge of alluvial and marine sediments resting on a basement complex of hard crystalline rocks. The surrounding mountains are block-faulted (Sierras) or folded (Coast Range).

BLM administered land is situated mainly on brush lands and coniferous forest above the valley floor. This land provides habitat for game fish, upland big game mammals, and game and nongame birds and mammals, anadromous fish ascend the Consumnes River.

Beneficial uses of the basin waters are municipal and domestic supply, irrigation, recreation, cold and warm fish habitat, spawning, wildlife habitat, and navigation. Of these, the Folsom District uses the waters for contact and noncontact recreation and fish and wildlife habitat.

Activities on BLM administered land that can possibly affect water quality include recreation, silvicultural, mining and grazing. A water quality concern has been identified for each one of these activities.

Grazing

One site specific grazing concern has been identified in this hydrologic area.

Electra Road (Potential)

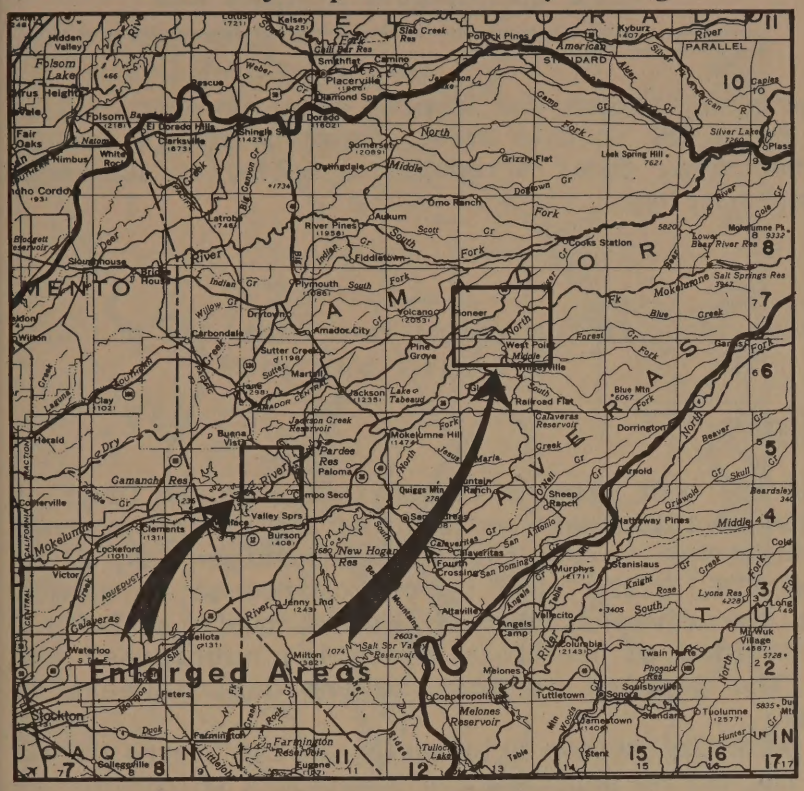
Cattle grazing is occurring along Electra Road which runs adjacent to an eight-mile stretch of the Mokelumne River from Highway 49 to Electra. The stretch passes through Sections 1 and 6, T5N, R12E, and Sec. 32, T6N, R12E, MDM (figure 3-20). The activity takes place along the flood plain and no provision is made to keep the animals out of the river channel and away from streambanks. The resulting pollution parameters are sediment, bacteria, nitrogen and phosphorous (nutrients), BOD, and turbidity. The magnitude of these pollutants is not known because data has never been collected, but during summer months, when flows are lowest and grazing is high, the problem is most severe.

The Mokelumne River is perennial and flows into Pardee Reservoir about 2 mi (3.2 km) from the downstream end of the area of concern. The local topography is rolling hills with elevations from 700 ft (213 km) to 1800 ft (548 km).

Effect On Beneficial Uses: Beneficial uses affected for both the Mokelumne River and Pardee Reservoir include municipal water supply, contact and noncontact recreation, fish habitat and spawning. These beneficial uses apply to BLM administered lands as well as downstream users. Possible adverse effects are poorer quality primary drinking water, limited or no contact recreation, decreased fish populations, and algae growth.

Information Needs: Monitoring is needed upstream and down-stream

Sacramento-San Joaquin Delta Hydrologic Area



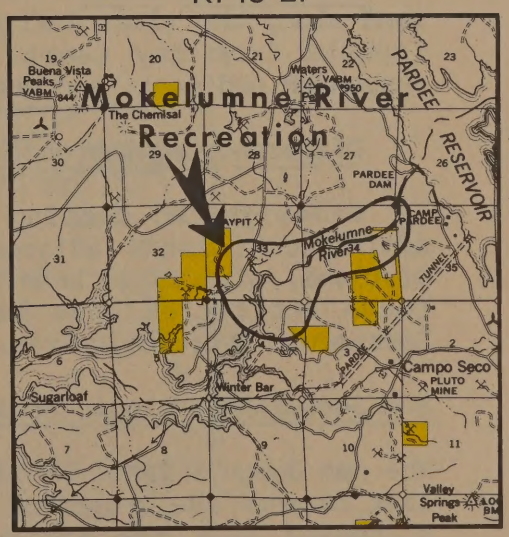
U.S. Bureau of Land Management
FOLSOM DISTRICT
WATER QUALITY PROBLEM ASSESSMENT

MOKELUMNE RIVER

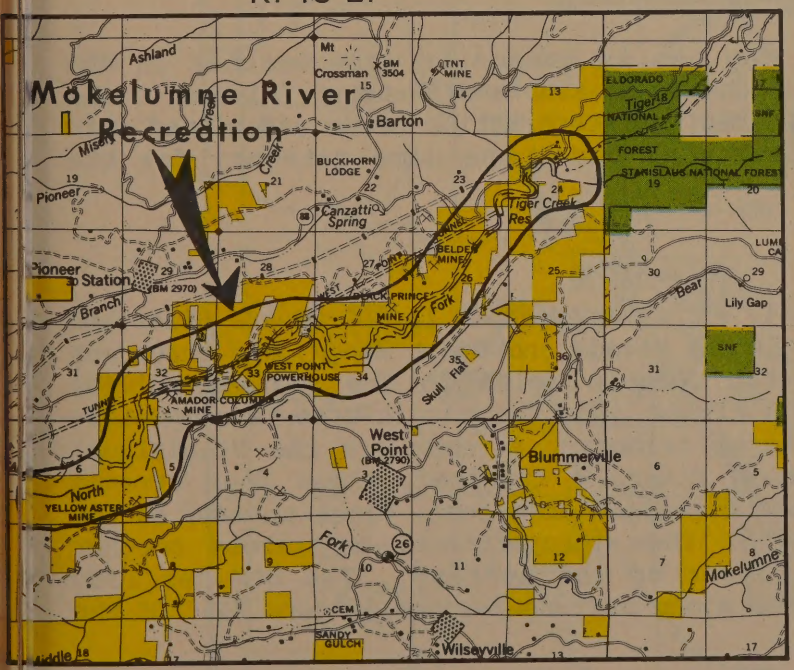
LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands

R. 10 E.



R. 13 E.



Mt. Diablo Base and Meridian

½ Inch = 1 Mile

Figure 3-21

from area of concern to correctly assess the impacts from improper grazing and to point out the need for a BMP in this area. Sampling should include total and fecal coliform bacteria, fecal streptococci bacteria, suspended sediment, turbidity, BOD, and nutrients.

Recreation

Recreation concerns have been identified as being both area-wide and site specific.

Mokelumne River (Existing)

The Mokelumne is one of the most popular rivers in the Folsom District for day use activities. BLM administered land adjoins the river for about 16 mi (26 km) at various stretches in the following townships: T4N, R10E; T5N, R10E; T6N, R12E; and T7N, R13E. Day users congregate in easily accessible sites alongside the river (figure 3-21) and their activities lead to elevated concentrations of coliform bacteria, nutrients, and sediment in the water. The problem is most severe during weekends throughout the summer months.

The Mokelumne River, a perennial stream originating in the Sierra Nevada Mountains, discharges into the Pardee and Camanche Reservoirs which in turn empty into the Sacramento River.

Effect On Beneficial Uses: Beneficial uses of the Mokelumne River include municipal water supply, contact and noncontact recreation, fish habitat and spawning. The largest impact stemming from day use activity is on municipalities due to coliform bacteria. Problems resulting from nutrients and sediment are minor.

Information Needs: A sampling scheme that brackets BLM administered land along the river during heavy use is necessary to accurately assess the impacts from day users. Data needed are fecal streptococci counts, suspended sediment, and nutrient (nitrogen and phosphorous) levels.

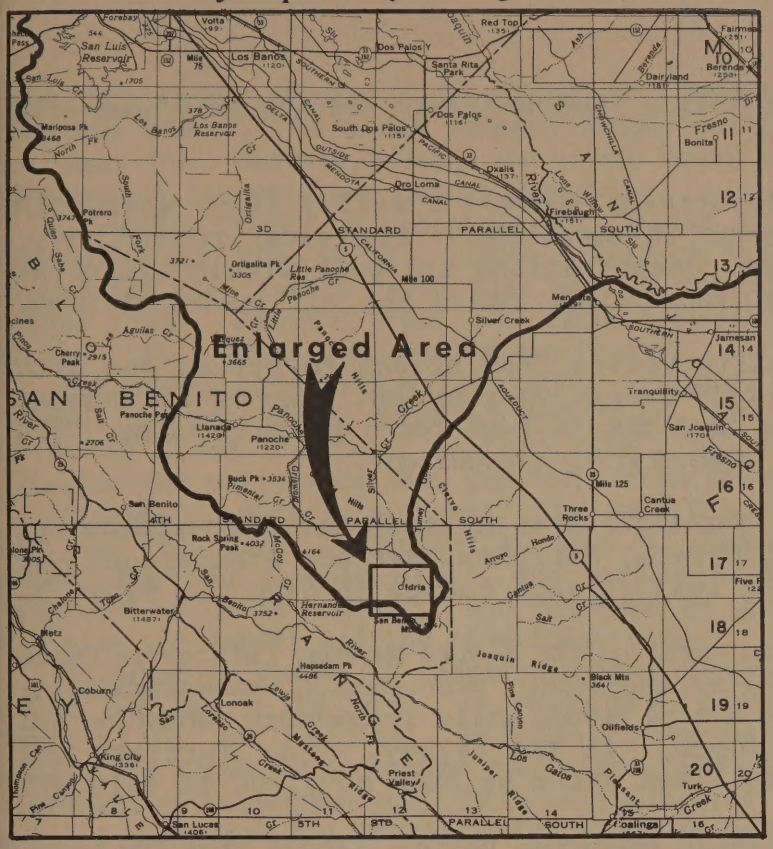
Dispersed Camping and Day Use (Suspected)

Undesignated camping and day use is common in warm weather on BLM administered lands adjacent to the Mokelumne and Cosumnes Rivers. The problems, effects on beneficial uses, and information needs associated with these activities have been described under the same category for the Sacramento Hydrologic Area.

San Joaquin Hydrologic Area

The San Joaquin Basin (Figure 3-1) encompasses about 11,000 square miles and lies between the crests of the Sierra Nevada and Coast Range, and stretches southward from the Sacramento-San Joaquin delta to the drainage divide between the San Joaquin and Kings Rivers. The hydrologic area is completely within the Folsom District. Major tributary streams are the Stanislaus, Tuolumne, Merced, and San Joaquin Rivers. Combined, these four streams produce an annual runoff of about 6 million acre-feet. Minor streams on the west side of the valley, many of them intermittent, contribute another 120,000 af (1.5×10^8 m^3) per year on the average. The BLM has land adjacent to the four major streams along various reaches (figure 2). Of the

San Joaquin Hydrologic Area



U.S. Bureau of Land Management
FOLSOM DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

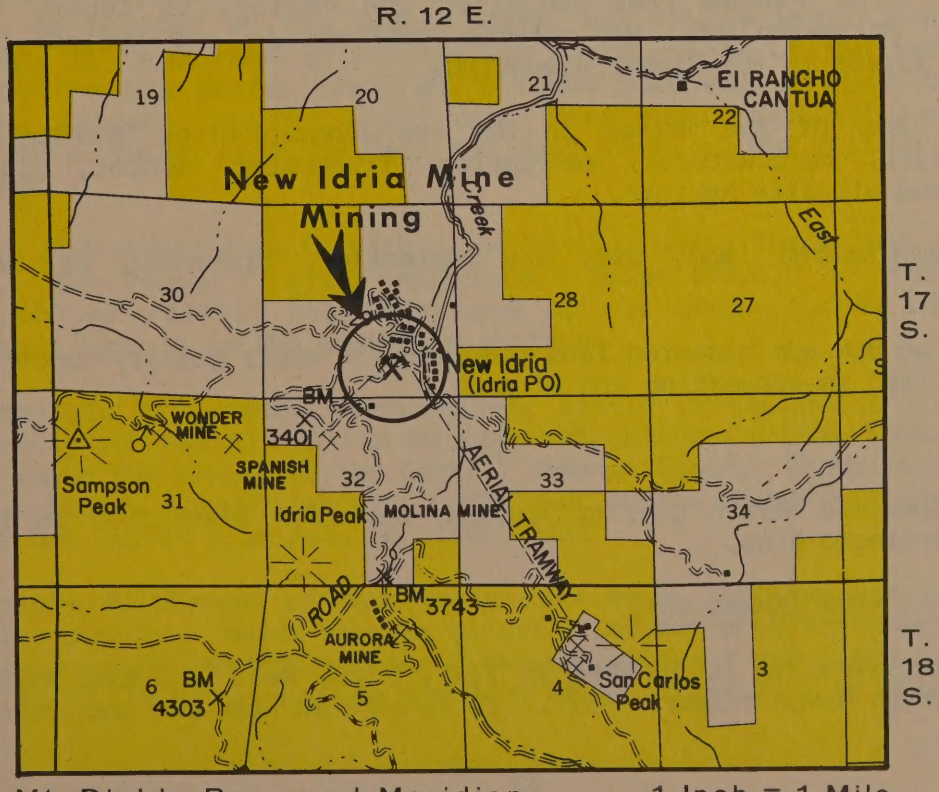
NEW IDRIA MINE

LEGEND

~ Existing Problem Area

Patented Lands

Public Lands (BLM)



Mt. Diablo Base and Meridian 1 Inch = 1 Mile

Figure 3-22

eastside streams, Panoche and Little Panoche Creeks are the only ones with BLM administered land adjacent.

Water quality in Sierraside streams above the valley floor where BLM administered land lies adjacent is excellent. Electrical conductivity, chloride, boron, and nitrate concentrations are well within limits of Class 1 irrigation water and recommended limits for all municipal uses.

Coastside stream water quality varies from stream to stream and with quantity of flow which occurs only during rainy months. Most of the streams are unsuitable for beneficial uses due to high boron concentrations (71.0 mg/l) and /or high electrical conductivity (71,000 oh).

Counties in the San Joaquin Hydrologic Area in which the BLM administers land are Calaveras, Fresno, Madera, Mariposa, Merced, Stanislaus, and Tuolumne. The extent of BLM land in each county is given in Table 1.

The hydrologic area lies within parts of the Sierra Nevada, California Coast Ranges, and Great Central Valley geomorphic provinces. Non-waterbearing crystalline rocks dominate the Sierra Nevada while sedimentary sandstone and shales make up the Coast Ranges. In the Valley, Upper Tertiary and Quaternary sediments contain fresh water as deep as 2,000 ft (610 m).

Climate, similiar to the two above mentioned basins, ranges from the warm, two-season Great Central Valley climate, to the cold, four season Sierra Nevada climate.

Wildlife in the basin consists of deer, fox, marten, fisher, and wolverine, and also upland game species such as quail, dove, rabbit, and pigeon. The cold water streams and lakes support year-round lake and stream trout. Vegetation type ranges from marsh in the valley, to aspen, willow, cottonwood, Galt-woodland, and savanna woodland in the uplands, and to coniferous forest in the higher elevations.

Beneficial uses of the waters in the San Joaquin River Hydrologic Area are municipal, agricultural, recreation, freshwater habitat, migration, spawning, and wildlife habitat.

On BLM administered land, uses are recreation, fisheries, and wildlife habitat.

Activities on BLM administered land resulting in water quality concerns have been identified as recreation and mining.

Mining

One site specific water quality concern has been identified in the San Joaquin Hydrologic Area.

New Idria Mine (Suspected)

This mercury mine is located in T17S, R12E, Sec. 29, MDM, within the Diablo Mountain Range (figure 3-22). It is both an open pit and underground

mine, but is not presently in operation. Even though the mine itself is on patented land, it is a BLM concern since public water resources completely surround it. Mercury, iron, and other heavy metals coming from mill and mine wastes are entering nearby drainages.

Griswold Creek, an intermittent stream originating 1.5 mi (2.4 km) southwest of New Idria, flows directly through the mining area and discharges into Carlos Creek just east of the mine. The flow proceeds into Silver Creek, Panoche Creek and eventually dissipates on the east slopes of the Diablo Range and San Joaquin Valley.

Pollutants enter the water during continual wet periods or during heavy storms, due to sheet erosion, stormflow, and groundwater flow into the Griswold Creek channel. During this time, the creek will be flowing, carrying the pollutants into the downstream drainages.

Effects on Beneficial Uses: The waters have been used for grazing but are now too toxic. Beneficial uses of Panoche Creek, which eventually enters the San Joaquin River, are agricultural, industrial, recreational, fish and wildlife habitat, and groundwater recharge. Heavy metals from the mine can impair all the beneficial uses.

Information Needs: A sampling scheme on the waters of San Carlos Creek, above and below the mine, is necessary to determine the actual impacts. Sampling for pH (acidity), asbestos, suspended sediment, and heavy metals during low flows is necessary for an accurate assessment. Also, it would be informative to compare pollutants originating from the mine with groundwater quality data from the Fresno Slough area for possible correlation.

Pajaro Hydrologic Area

The Pajaro River Hydrologic Area (figure 3-1) consists of a long narrow northeast trending interior valley which drains through Pajaro Gap to a coastal plain fronting on Monterey Bay. The narrow interior valley is structurally continuous with the Santa Clara Valley. On the east, the sub-basin is bounded by the Diablo Range and on the west, south of the Pajaro Gap, it is bounded by the Gabilan Range. Most of the sub-basin is drained by the San Benito River which flows northwest to join the Pajaro River just upstream from the Pajaro Gap. Many small tributaries empty into the San Benito River from the west and east sides of the valley, including Clear Creek.

The Pajaro Hydrologic Area is within San Benito, Santa Clara, and Santa Cruz Counties. The Folsom District administers about 135,000 ac (54635 ha) of the 833,000 ac (337115 ha) that make up the basin. Most of the BLM administered land is in the southeast portion.

This hydrologic area receives relatively little precipitation compared to the westernly sub-basins. As can be expected, average stream flows per unit area are among the lowest in the Central Coastal Basin. These streams often exhibit a flashy runoff pattern. The San Benito River's discharge near Hollister has varied from zero to 11,600 cfs.

Approximately 90 percent of hydrologic area water requirements are met by groundwater pumping. Water-bearing alluvial sediments of Pliocene and upper Quaternary ages are extensive beneath the valley floor and reach a thickness of 4000 ft (1219 m) along the eastern edge. The area is divided into

several groundwater sub-basins due to faults which restrict lateral movement of groundwater. Several reservoirs have been constructed primarily for the purpose of groundwater recharge.

The geology of the area is extremely complex. The mountain ranges were formed by intense folding and faulting of complex rock groups. Both the Hayward and San Andreas Faults, major active faults, pass through the sub-basin. Surface evidence of the San Andreas Fault is extensive.

Vegetation types in the basin range from marsh to coniferous forest and support various animal species. On BLM administered land, chaparral-scrub communities support jays and deer; coniferous forests support deer, bear, and quail; and woodlands support songbirds, quail, deer and bear.

Soils on BLM land are for the most part shallow and loosely consolidated. As slopes in the area are steep, soils are very susceptible to erosion.

Beneficial uses of the waters are groundwater recharge, agriculture, recreation, wildlife habitat, and warm fresh-water habitat. Of these, the BLM is mainly concerned with wildlife habitat.

Activities on BLM land in the hydrologic area that have reason for water quality concern are recreation and mining.

Mining

One mine in this hydrologic area has been identified by several sources as a major pollutant source.

Union Carbide Mine (Existing)

This open pit mine is located between Santa Rita Peak and Condon Peak within T18S, R12E, Sec. 25, MDM. Asbestos is being dumped into small drainages in the vicinity of the mine, all of which are intermittent streams. However, large or numerous small runoff events result in the pollutant being carried to the San Benito River, an intermittent stream which empties into the Hernandez Reservoir.

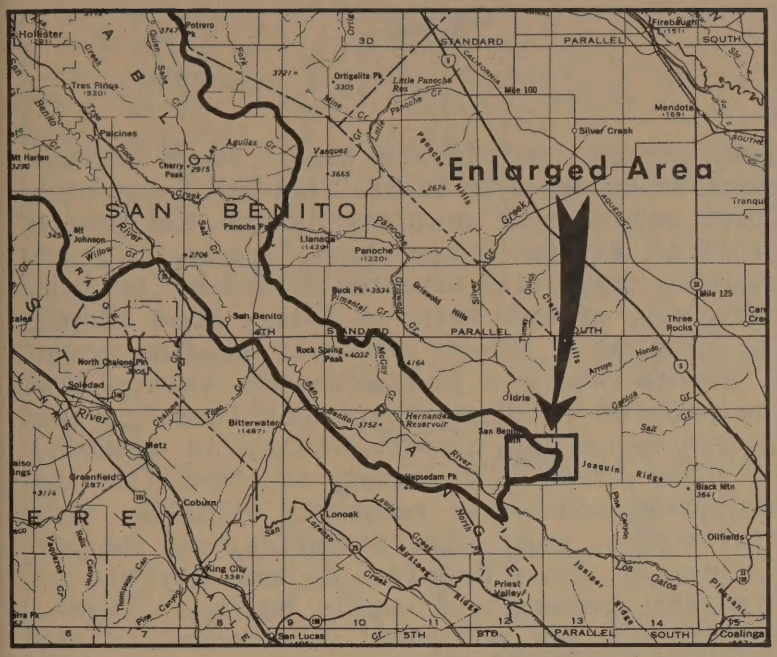
Effect On Beneficial Uses: The waters are used on BLM land for wildlife habitat and downstream for groundwater recharge, agricultural supply, wildlife, and warm fresh-water habitat. Effects of heavy asbestos loads in the water reduces the capacity of the Hernandez Reservoir, clogs pores in groundwater recharge areas, reduces fish populations, and, at high concentration, is toxic to wildlife.

Information Needs: A monitoring system designed to quantify the pollutant coming from the mine only (as compared to natural sources) would be necessary to determine the actual impacts on beneficial uses. This data would then help in resolving the need for and extent of a BMP for the mine.

Natural

Natural erosion has been identified as the largest contributor of sediment on BLM land in the Pajaro Hydrologic Area.

Pajaro Hydrologic Area

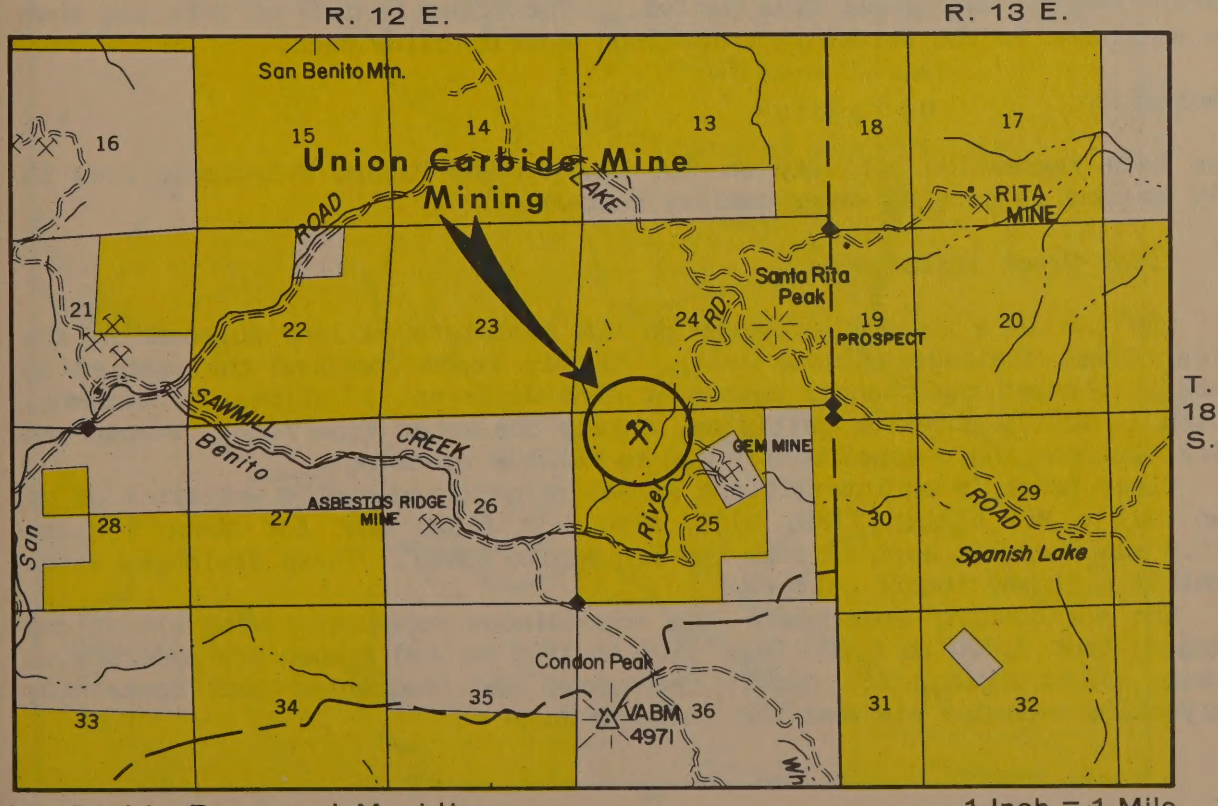


U.S. Bureau of Land Management
FOLSOM DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

UNION CARBIDE MINE

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)



Mt. Diablo Base and Meridian

1 Inch = 1 Mile

Figure 3-23

Clear Creek (Existing)

Natural erosion on BLM administered land in the Diablo Range it has resulted in high levels of chrysotile asbestos in Clear Creek and San Benito River (figure 3-24). Clear Creek and eastern sections of the San Benito River watersheds contain outcrops of extremely weathered, fragmented, and decomposed serpentine rock containing chrysotile asbestos minerals. No soil or vegetation covers the outcrops, many of them being on fairly steep slopes approximately 30-40 percent in gradient. Sheet and rill erosion occur during rainfall and runoff events whereby the asbestos enters the drainages. The extent of the problem is directly proportional to the storm's magnitude. However, the degree of proportionality is unknown.

Effect On Beneficial Uses: Clear Creek is tributary to the San Benito River which is used for agriculture, groundwater recharge, wildlife, fish habitat, municiple and industrial supply, warm water fisheries, and contact and noncontact recreation. Most of these beneficial uses pertain to the Hernandez Reservoir of which the San Benito River is the main source. Extreme sediment loading and siltation are obviously detrimental to the above beneficial uses.

The main use of the Hernandez Reservoir is groundwater recharge. Percolation of water into the groundwater basin is decreased due to asbestos clogging pores in underlying quaternary deposits. Also, silting in the Hernandez Reservoir is so great as to decrease the storage capacity.

Information Needs: Asbestos loads in Clear Creek have been so high as to be uncountable (in terms of particles per million). However, a sampling scheme that measures suspended solid concentration (mg/l) during a complete range of flows would be beneficial to determine the actual amount of suspended solids entering the reservoir. When combined with discharge data, suspended sediment rating curves can then be developed, and thus total sediment (in terms of weight) discharging from the drainages can be determined for any given time period. The effectiveness of BMPs can then be monitored in the future by comparison with baseline data.

Recreation

The main recreation activity on BLM land in the Pajaro Hydrologic Area is ORV use and is causing water quality concern.

Clear Creek (Existing)

ORV use is a popular activity on BLM administered land surrounding the Clear Creek drainage (figure 3-25). County roads compound the problem by cutting through the channel bottom at nine different locations. Sediment, which is mostly asbestos particles, enters the water from runoff events and directly from the channel bottom due to vehicle crossings.

Clear Creek is an intermittent stream originating on the western side of San Benito Mt. within T18S, R12E, MDM. It flows west for about 8 miles (12.8 km) where it empties into the San Benito River. These drainages often exhibit a flashy runoff pattern.

The surrounding area has a low, mountainous topography with elevations ranging from 2,000 to 6,000 feet (610 to 1829 m) and slopes are moderate to steep. Outcroppings of highly decomposed and fragmented rock containing chrysotile asbestos are abundant throughout.

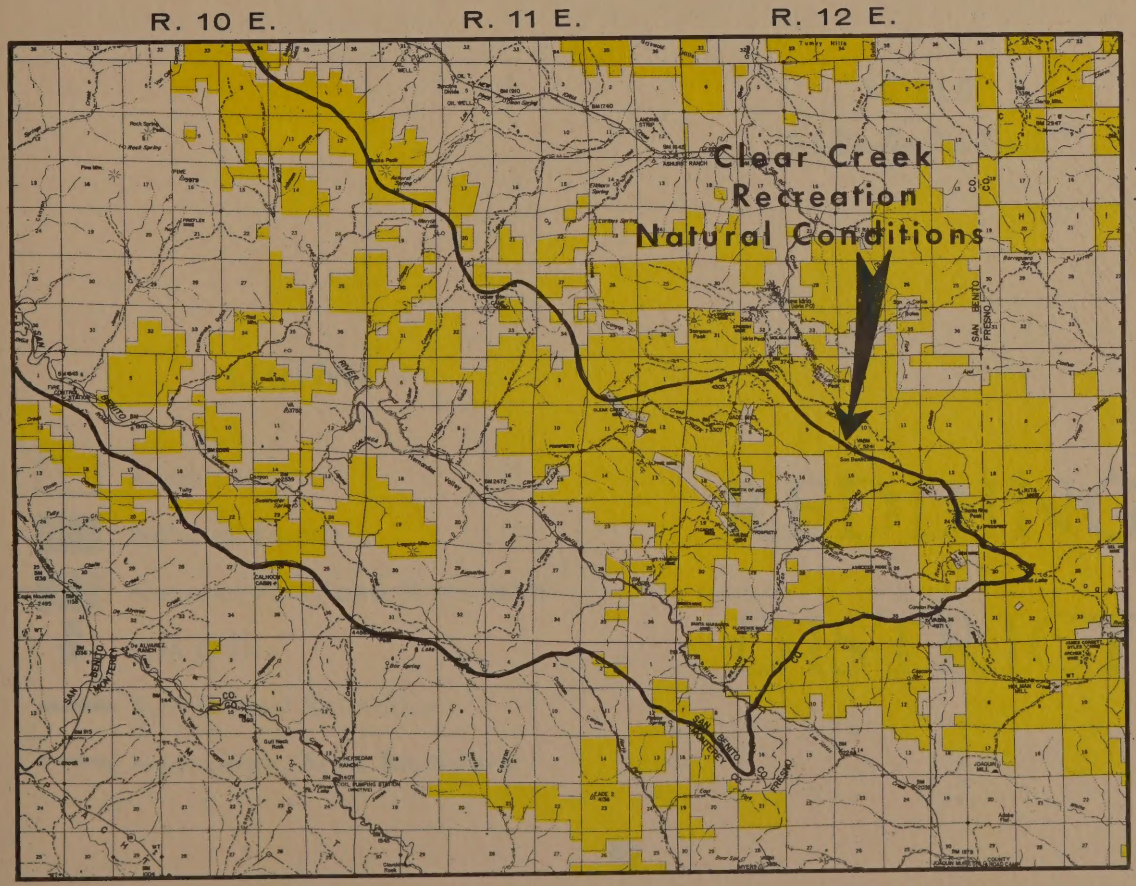
U.S. Bureau of Land Management
FOLSOM DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

CLEAR CREEK

Pajaro Hydrologic Area

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)



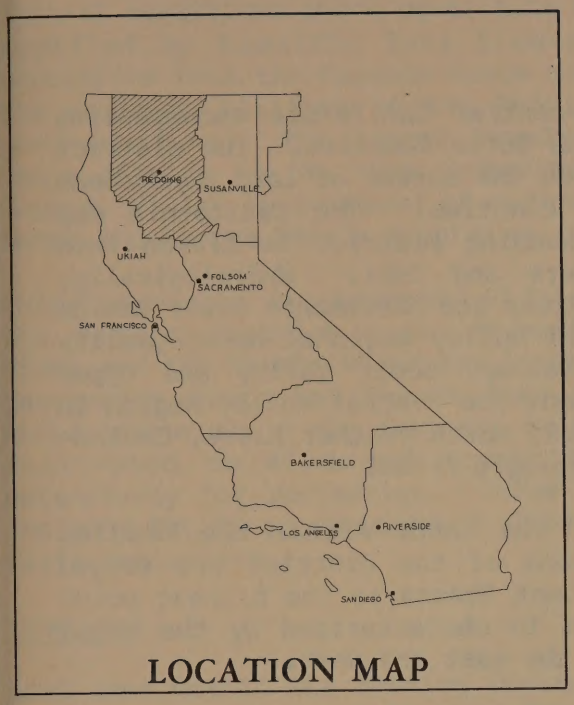
Mt. Diablo Base and Meridian

¼ Inch = 1 Mile

Figure 3-24

Effects On Beneficial Uses: The waters are used on BLM lands for wildlife habitat, and are used downstream for groundwater recharge, agricultural supply, wildlife habitat, and warmfresh water habitat. Heavy sediment and asbestos loads in the water reduce the capacity of the Hernandez Reservoir, clog pores in groundwater recharge areas, reduces fish populations, and are toxic to wildlife.

Information Needs: (same as Clear Creek "Natural" problem).



LOCATION MAP

LEGEND

- Public Lands
- National Forests
- National Parks and Monuments
- BLM Office
- BLM District Boundary
- Hydrologic Area Boundary

REDDING DISTRICT

Figure 3-25

REDDING DISTRICT

The Redding District is located in north-central California encompassing Siskiyou, Trinity, Shasta, Tehama, Glenn and Butte Counties. The district covers approximately 7,840,000 acres of which the Bureau of Land Management administers 351,440 acres within the six counties. The California map identifies the district boundaries. The Redding District is broken into three Resource Areas: Siskiyou, Four Rivers and Ishi. Hydrologically, the Redding District is within the Klamath River and Sacramento River Basins as delineated by the North Coast and Central Valley Regional Water Quality Boards. The Upper Trinity River, Shasta Valley, Scott Valley and Upper Klamath River Basin of the North Coast Region. The Central Valley Region in the Redding District includes the Butte Creek, North Feather River, Cottonwood Creek, Stony Creek and Whiskeytown Hydrologic Areas.

The physical characteristics and uses of the lands within the Redding District vary widely. The northern portions of the district are rugged mountains intersected by narrow valleys. Mount Shasta is the highest point within the District. The southern portion is characterized by the broad Central Valley and grades into foothills to the east and west.

Agriculture and rangelands are the principal land use categories of the upper Central Valley while forest and rangeland predominate the northern portion of the District. Public lands are utilized primarely for wildlife habitat and range land. Timber harvesting and mining are the principal commercial uses of public lands in the Redding District.

Rugged and steep describes the majority of the northern half of the District. The Klamath River is the major water course in the north. The Sacramento River and the upper Trinity River are the principal drainages for the remainder of the Redding District. Within the District, Shasta, Whiskeytown, and Clair Engle Reservoirs are the major multi-functional water projects.

Physical Description

The climate of the Redding District is influenced by the seasonal pattern of northern Pacific storm systems. Precipitation generally occurs during the winter months and is principally in the form of snow above the 4,000 to 5,000 foot elevations. The northern mountain areas receive the highest precipitation amounts and the southern portion of the Redding District record the lowest. Annual precipitation varies between 10 and 80 inches within the District. There is a definite seasonal variation in temperatures in the Redding District. Alpine climate characterizes the mountains with average temperatures ranging from 24°F to 68°F. Hot summers and mild winters with light precipitation are typical of the upper Central Valley where temperatures range from 44°F to 80°F.

The geophysical features of the Redding District are predominatly mountains. The Klamath Mountains, north Coastal Range, Cascade Range, and the Sierra Nevada Mountains comprise the major mountain regions within the district. The Klamath and north Coastal Range mountains are subject to mass wasting and erosion. Decomposed granite, faulting, and shallow soils are

natural conditions which contribute to those problems. The Cascade Range is typified by basaltic lava flow and volcanic activity. The volcanic deposition from the Cascade Range comprises most of the valley formations in the northern portions of the Redding District. These formations provide good aquifers. The Sierra Nevada Mountains are a block tilted granitic range dipping to the west underlying the upper Central Valley. The upper Central Valley is composed of sediment deposition from the northern Coastal Range and Sierra Nevada Mountains.

Water resources are represented by the three major drainage systems within the Redding District. The Klamath River and its tributaries, the Scott River and the Shasta River are in the northern portion of the district. The Sacramento River and Shasta Lake are important commercial and recreation water resources in the southern half of the district. The Trinity River is designated as Wild and Scenic by the State of California and used extensively for recreation. Other water resources in the Redding District include: Pit River, Cottonwood Creek, Butte Creek, Whiskeytown Reservoir and Clair Engle Lake.

Land Use

Land uses within the Redding District are numerous. BLM lands are managed predominately for grazing, mining, wildlife habitat, timber harvesting, recreation, and rights-of-way. Agriculture, mining and timber harvest are the major commercial interests in the District. Urban and industrial development is minimal and centers around the Redding area. Recreational use within the Redding District is closely correlated to the water resources in the area. Fishing and boating are two major forms of recreation occurring. The mountains, abundance of Federal lands (National Forests, National Parks, and public land) and large river systems are the key factors in the attraction for recreation in the Redding District.

Mining has historically occurred in the Redding District since the Gold Rush period. Hydrologic, underground, and placer mining for locatable minerals has occurred in the Klamath-Modoc Plain and the Sierra Nevada foothills of the Redding District. Most of the drainages in the Klamath and Trinity River systems have been altered from their natural conditions by dredging.

Generally, the large dredging operations have stabilized with time, but discharges from abandoned underground mines are creating water quality concerns. Some open pit or surface mining is occurring, but underground mines are the chief mining operations in the District. Unreclaimed mining spoils are a source of sediment and heavy metals which are causing concern as to their effects on adjacent water courses and resources. Abandoned mining operations are numerous, occurring quite often on Federal land administered by the BLM and Forest Service. Because much of the mining is for locatable minerals, it is regulated by the 1872 Mining Law which gives little or no regulation or management authority to the Federal land managing agencies.

Timber harvesting is a major commercial activity in the western and northern portions of the Redding District. Timber harvesting is occurring primarily on National Forest lands and on patented lands. The BLM presently sells

timber for harvest throughout the District but generally in small sales for stand improvement. There are plans for more timber harvesting on BLM lands in the future. Timber harvesting has been a source of stream degradation, sedimentation and erosion in the past. Poor logging practices in the Upper Trinity River hydrologic area have caused water quality concerns in terms of sedimentation, thermal loading, and stream bank degradation. A few of the watersheds have been cut with no provisions to include buffer zones along drainages. Drainages have been used as skid trails and some timber has been cut adjacent to streams with viable fishery habitat. These practices have resulted in detrimental impacts to the water resources for water quality and fishery habitat. Steep slopes and erosive soil types in much of Redding District's forested areas have the potential for contributing to water quality problems from timber harvest. Many of the streams in the forested areas contain fisheries, which can be detrimentally impacted by improper or poor timber harvest practices. New timber harvesting techniques and practices, when applied, can mitigate future water quality problems.

Livestock grazing occurs throughout the Redding District. Livestock operations on BLM lands within the District are primarily under Section 15 permits. Much of the rangeland is annual grass or chapparral. Range management in the Redding District appears to be in accord with proper range management procedures and policy. None of the rangelands are presently identified as overgrazed or in poor condition. There is potential on a District-wide basis for water quality problems associated with grazing due bacterial pollution. Lack of stream and water resource inventories may be the reason no water quality problems associated with grazing have been identified to date.

Water based recreation predominates throughout the Redding District. Recreation activities on BLM administered lands are diverse. Water resources attract many users for fishing, boating, floating, and placer suction dredging. Camping and hunting also make up a substantial portion of the recreational use.

The physical appearance of recreational water is important, as the aesthetics of the water resources are very critical to recreational enjoyment. The shortage of recreation facilities and the lack of control of user numbers has had an impacted on a few water based recreation sites. Improper or indiscriminate sanitary waste disposal has negatively impacted a few streams. Random dumping on BLM administered land throughout the District occurs and does affect aesthetics and water quality to a certain degree. The Douglas City dump and the old Shasta dump both affect water resources adjacent to the sites. As recreational use increases the potential increases for water quality problems associated with recreational use and inadequate facilities.

Much of the Redding District provides wildlife and fishery habitat. The undeveloped lands provide habitat for varying wildlife species. Much of the chapparral and forested areas support game and non-game species. The remoteness of much of the northern half of the District is conducive to wildlife. Insuring protection of water resources and natural flow regimes is a function of BLM wildlife and fisheries management. The numerous perennial streams provide habitat for various fish species. Man's

activities often encroach or detrimentally affect wildlife and fisheries habitat, i.e., hydroelectric power generation, irrigation diversions, and sanitary waste disposal. Water quality problems associated with wildlife and fisheries habitat management are increasing as man's development of the land increases.

Lands administered by the BLM are utilized for various community and public services. Power lines, pipelines, roads, and landfill sites are permitted by the BLM. Landfill operations often sources of pollution of water resources adjacrent to landfill sites. The location of landfills and operations techniques are the important aspects in managing landfill operations to insure that water resources are protected. Further description of landfill operations can be obtained in the "BLM Solid Waste Management Practices". Environmental analyses made prior to the issuance of a BLM right-of-way permit should address and insure mitigation or protection of water resources which could be affected.

Butte Creek Hydrologic Area

The Butte Creek Hydrologic Area is located on the eastern side of the Sacramento River Valley adjacent to Chico, California. Lands administered by the BLM consist of scattered isolated tracts in the foothills adjacent to the Lassen National Forest. Activities conducted on public lands in the hydrologic area include mining, recreation, grazing, water diversion, and fisheries.

Butte Creek is the principal drainage and water resource in the hydrologic area. The area encompasses the foothills of the Sierra Nevada Mountains and a portion of the Sacramento River Valley. The foothills consist of steep granitic hills which grade into alluvial plains of the Great Valley Basin. Precipitation, mostly in the form of rain, is less than 20 inches annually. Snowmelt runoff from the Sierra Nevada Mountains accounts for the peak flows in Butte Creek. Butte Creek is diverted and utilized for power generaton in the upper reaches and utilized for irrigation in the lower reaches near its confluence with the Sacramento River. Mining for locatable minerals occurs within the hydrologic area.

BLM beneficial uses of Butte Creek include recreation, wildlife management, fishery habitat and range management. The steep terrain limits access to and precludes extensive use of the water resources for recreation and fishing. Access by public lands and the proximity to Chico have contributed to the increase in public demand for recreational use in the Butte Creek hydrologic area.

Recreation

Butte Creek (Suspected)

Day use, picnicking, suction dredge mining, and fishing are the recreational activities occurr on BLM administered lands along Butte Creek. These uses are suspected to be adversely affecting the water quality of Butte Creek. The suction dredging is suspected to be producing above normal amounts of suspended sediment. The concentrations of people adjacent to the water course have the potential to cause fecal pollution, as there are no sanitary facilities in the immediate area.

The major suspected pollutants are sediment and turbidity, and possible E. coli bacteria pollution. These problems generally occur during warm weather when outdoor recreation of this type occurs.

The magnitude or extent of recreational use is undefinable at this time, but probably does not extend downstream from the power house because of the private lands and inaccessability of the creek. Sediment will affect downstream water quality until it either settles out or is diluted. The steep slopes of the canyon in the power house area prevent widespread recreational use and limit access to the area. The majority of use is adjacent to the road crossing near Forks of Butte.

Effects On Beneficial Uses: Sediment and bacterial pollution are detrimental to the recreational enjoyment, the aesthetics of water based recreation, and any fisheries or potential fishery.

Mining

Butte Creek (Suspected)

Sedimentation and heavy metals being carried into Butte Creek by runoff from mine spoils are a water quality concern in this area. Unreclaimed mine spoils and tailings are very susceptible to erosion during rain storms. There are various underground mining operations in the Butte Creek watershed.

The Butte Creek area is above Paradise, California as identified on the Central Valley map. The stretch of Butte Creek considered is near Forks of Butte.

The winter rains generally produce runoff which carry sediment and any possible toxic metals associated with unreclaimed mine spoils and tailings. The sources of these types of sediments can be attributed to the Blacks Diamond and Royal Drift mines adjacent to BLM administered lands along Butte Creek. The magnitude of this problem is difficult to determine -- during the winter rainy season sediment is produced from other sources as well as the mines. The steep slopes of the Butte Creek Canyon are susceptible to accelerated erosion where surface soils are unreclaimed.

Effects On Beneficial Uses: Beneficial uses of Butte Creek include recreation, wildlife watering, fishery habitat, power generation, irrigation and wildlife habitat. Sedimentation and heavy metals from mining spoils will detrimentally affect the BLM management of recreation, fish habitat and wildlife water on Butte Creek.

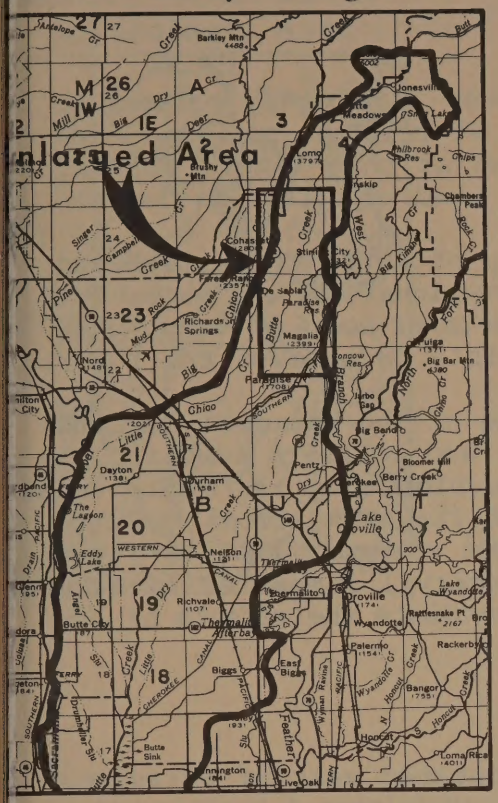
Diversion and Return Flow

Butte Creek (Existing)

The Pacific Gas and Electric Company (PG&E) diverts water from Butte Creek for utilization in hydro-electric generating plants. Diversion of waters from natural stream channels results in unnatural low flows in the stream. Low flows and the diversion structures have eliminated the anadromous fishery of the Upper Butte Creek and detrimentally affected the fishery habitat.

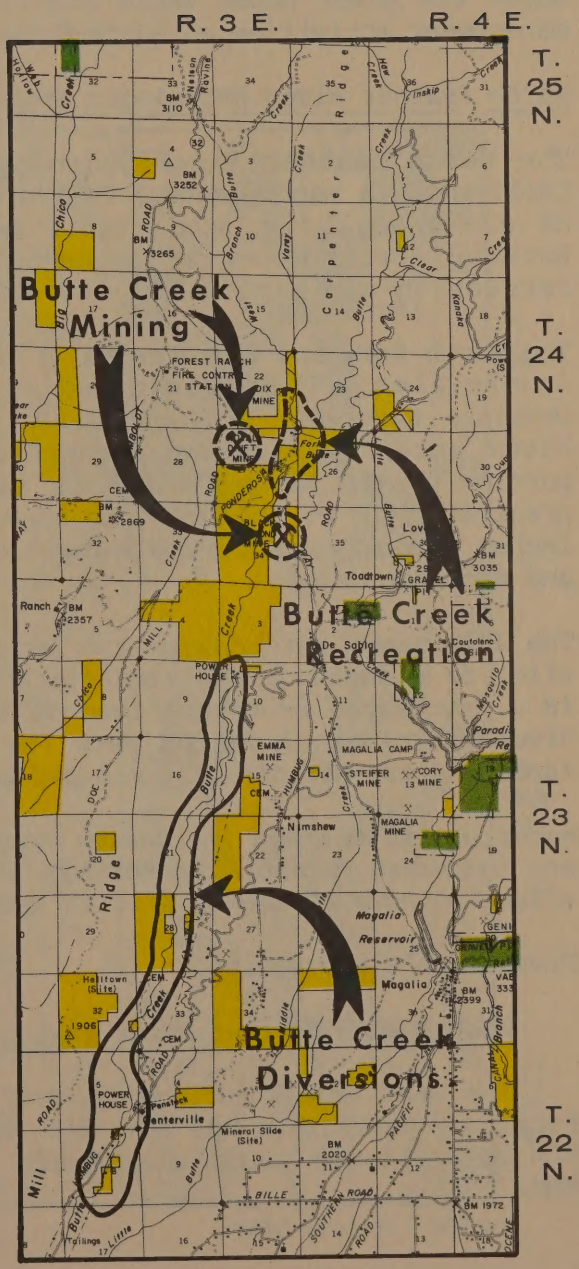
The water quality problems in Butte Creek associated with low flows are temperature increase, decreased dissolved oxygen, and increased dissolved solids concentrations. These problems are magnified when diversions occur during natural low flow periods of the late summer and when thermal loading

tte Creek Hydrologic Area



U.S. Bureau of Land Management
REDDING DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

BUTTE CREEK



LEGEND

- Existing Problem Area
- Suspected Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands

iablo Base and Meridian

Figure 3-26

4/10 Inch = 1 Mile

is critical under natural conditions. The cause is directly related to indiscriminate diversion of Butte Creek flows at critical periods. The magnitude of this problem is not fully known at this time. Further inventory of fish populations will identify the level of effect on the fish habitat.

Effects On Beneficial Uses: The fishery of Butte Creek is being impacted. The fishery is linked directly to recreational use and demand for the area. The use of Butte Creek upstream of the power house at Centerville for an anadromous fishery is no longer possible because of the power generating site and diversions.

Information Needs On Butte Creek: Monitoring of the water quality and quantity of Butte Creek is needed. Sediment and coliform sampling is essential to evaluate suspected water quality problems from recreation and mining along Butte Creek. Further inventory of fish populations in Butte Creek is needed in order to evaluate the magnitude of impact that low flows from diversions have had on the existing fishery. A monitoring site above the power house would enable the BLM to evaluate the effects of BLM management activities on Butte Creek.

North Feather River Hydrologic Area

The North Feather River Hydrologic Area is located east of Paradise, California in north central California. The BLM administered lands consist of a few small isolated tracts in the Hydrologic Area while the Lassen National Forest makes up the major portion of the area. Range management, recreation and mining are the main activities occurring on BLM lands.

The North Fork and East Branch of the Feather River are the major drainages in the area. They originated in the Sierra Nevadas and flow into the Oroville Reservoir and eventually flow into the Sacramento River. Feather River water is diverted for hydroelectric power generation. The upper portion of the North Feather is forested and receives the majority of the precipitation in the form of snow. Precipitation varies from 20 to 80 inches annually in the hydrologic area. Runoff results from winter rains and snowpack melt.

The BLM beneficially uses the water resources of the area in its range, wildlife management and recreation management activities. Fishery habitat is a recognized beneficial use of the water resources in the North Feather River Hydrologic Area but very few of the streams are on BLM administered lands and are not directly managed by the BLM for fisheries habitat.

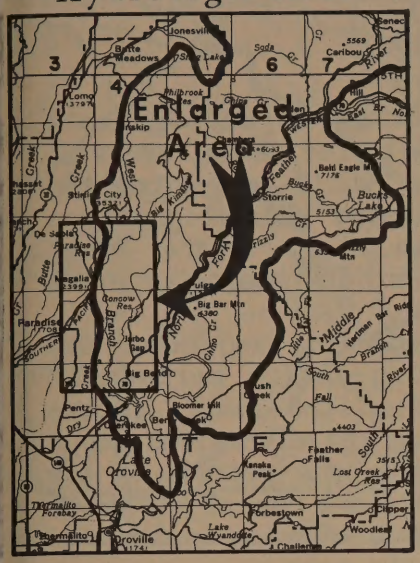
Water diversions and increasing recreational use of the North Feather River are creating potentially serious water quality problems and are presently affecting some of the beneficial uses of the North Feather River.

Diversions - Recreation

West Branch Feather River (Existing)

The West Branch of the Feather River above Oroville Reservoir east of Paradise, California has some BLM administered lands along the river. The BLM administered lands of concern are Sections 6, 8, 18, 20 T22N, R4E, MDM.

North Feather River
Hydrologic Area



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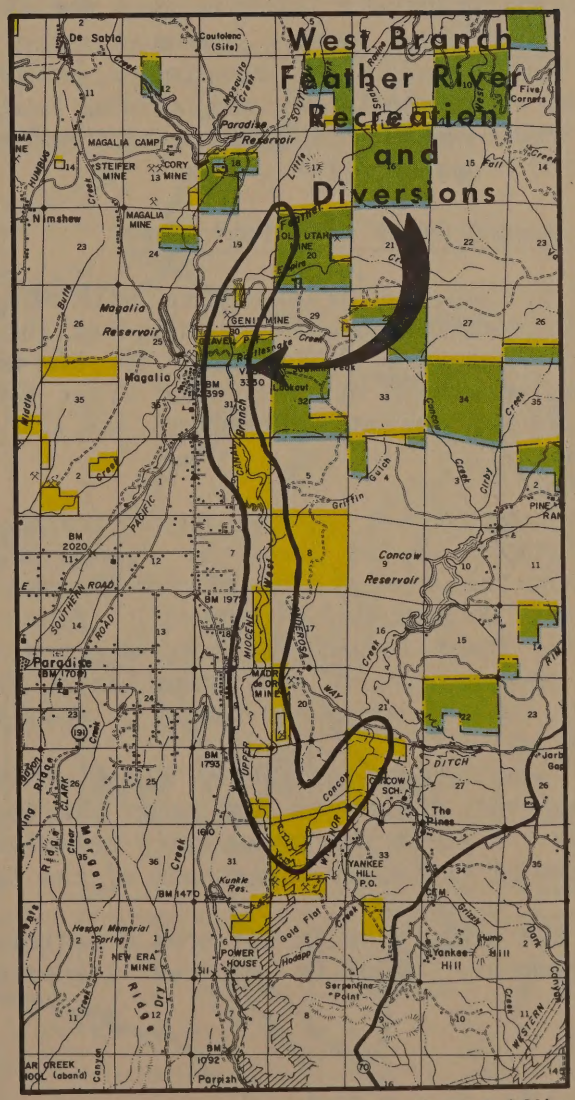
WATER QUALITY
PROBLEM ASSESSMENT

WEST BRANCH
FEATHER RIVER

R. 3 E. R. 4 E.



LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands

4/10 Inch = 1 Mile

Diablo Base and Meridian

Figure 3-27

The West Branch of the Feather River experiences considerable recreational use in the summer months. The proximity to residental areas of Paradise and Chico combined with easy access to the public land along the west branch are factors contributing to the increasing recreational use of the area. Water is diverted from the West Branch of the Feather River above the area described via the Upper Miocene Canal and is used to generate electricity at a P.G.&E. hydroelectric power plant.

The river is utilized for fishing, floating, swimming, and other day uses, and suction dredging. The water diversions during periods of naturally low flow put stress on the aquatic fauna of the river. Above normal temperatures resulting from decreased flow from the diversions are a problem for fish populations. Suction dredging during the periods of low flow produce detrimental sedimentation. Heavy recreational use of the river during summer months increases the incidence of bacterial pollution especially due to the lack of sanitary facilities in the area.

Effects On Beneficial Uses: The waters of the West Branch of the Feather River are beneficially used for power generation, recreation, wildlife habitat, livestock watering, and fish habitat. The river supplies Oroville Reservoir which is used for irrigation and other purposes.

Information Needs: Re-evaluation of the water diversion schedule and quantity should be completed prior to re-licensing. Environmental constraints should be incorporated into any re-license. Coliform monitoring is needed to determine the extent and magnitude of pollution from human use of and along the river.

Cottonwood Creek Hydrologic Area

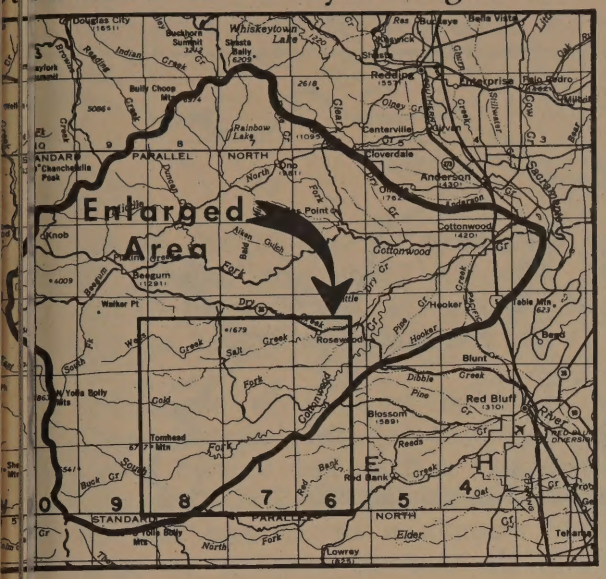
The Cottonwood Creek Hydrologic Area is part of the Sacramento River Basin draining the eastern slope of the North Coastal Range. And is located in north-central California. The BLM and National Forest lands comprise the upper watershed of Cottonwood Creek Hydrologic Area. Range management and wildlife habitat management are the predominate BLM activities in the area.

Cottonwood Creek is the major drainage within the hydrologic area. The topography varies from the folded mountains of the North Coastal Range to the alluvial plain of the Sacramento River Basin. The upper portion of the watershed is timbered. Brush chaparral and oak grasslands occur at the lower elevations. The steep slopes and erosive soils have potential for severe erosion. Precipitation on the eastern slopes is affected by the North Coastal Range and ranges from 20 to 40 inches per year.

The area is predominately rangeland with minor agricultural development along the drainages and near the Sacramento River. Steep slopes and chaparral limit the suitability for diversified land uses. Cottonwood Creek is one of the major watersheds of the Sacramento River.

The BLM activities in the area beneficially use the water resource for range management, wildlife habitat fisheries, and groundwater replenishment.

...onwood Creek Hydrologic Area



U.S. Bureau of Land Management
REDDING DISTRICT
WATER QUALITY PROBLEM ASSESSMENT

SKINNER MILL FIRE

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands

R. 8 W. R. 7 W. R. 6 W.

T. 28 N.

T. 27 N.

T. 26 N.

Skinner Mill Fire Area Wildfire

Mt. Diablo Base and Meridian

Figure 3-28

4/10 Inch = 1 Mile

Wildfire

Skinner Mill Fire (Existing)

The Skinner Mill Fire occurred in July 1976, and burned 75,000 acres. BLM lands comprised 15% of the area burned. The BLM lands are located in portions of T26 and 27N, R8 and 7W, as shown on the Cottonwood Creek Hydrologic Area map. The Skinner Mill Fire is in the upper watershed of the South Fork Cottonwood Creek.

Heavy rains immediately after the fire resulted in serious sheet and rill eroision of the burn area. The surface soils and ash were washed away. Aerial reseeding was ineffective because the growth medium was washed away. Fire breaks and trails have been successfully reseeded by drilling and disking. The burn area is in steep sloped mountain brushland and is experiencing extensive rill erosion coupled with headcut erosion in many drainages.

The effect of the mass erosion has been serious sedimentation in the South Fork Cottonwood Creek. The California Department of Fish and Game reported destruction of the fishery during the summer of 1976. Low flows, sediment and high nutrient levels were detrimental to the fishery. Stream monitoring of the South Fork of Cottonwood Creek conducted by USGS has found above-normal levels of suspended sediment and phosphorous. Natural revegetation by brush has occurred over much of the burn, and with above normal rainfall levels this year (1978), it is improving. The steep slopes and lack of seed bed have made any other reclamation efforts prohibitive.

Effects on Beneficial Uses: The burn has affected water quality of the South Fork of Cottonwood Creek in terms of increased sedimentation, turbidity and chemical constituents. The fishery of Cottonwood Creek has been adversely affected. This problem will continue until the burn area is stabilized through natural forces or reclamation is successful. Any storm, producing runoff, produces significant sediment in the South Fork of Cottonwood Creek.

Stony Creek Hydrologic Area

The Stony Creek Hydrologic Area is within the Sacramento River Basin and is located on the eastern side of the North Coastal Range in north-central California. BLM administered lands are scattered throughout the upper watershed adjacent to National Forest lands. Grazing and wildlife habitat are the activities which utilize BLM lands in the area.

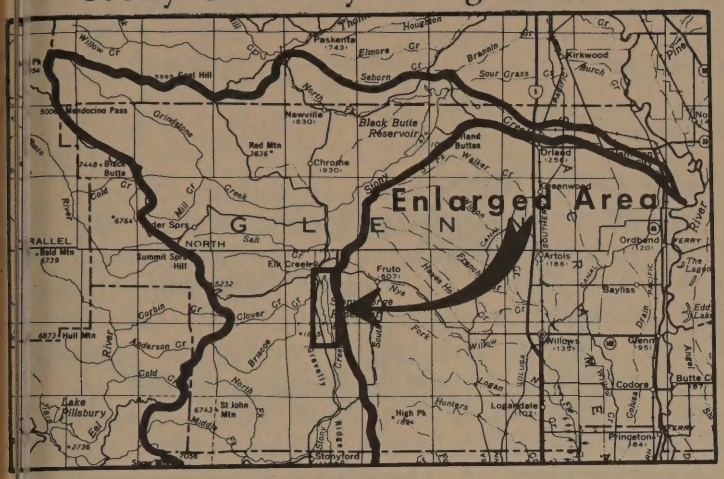
Stony Creek and Stony Gorge Reservoir are the principal water resources in the Hydrologic Area. The Stony Creek area is characterized as the foothill region of the North Coastal Range. Precipitation ranges from 10 to 35 inches annually and occurs generally during winter months. Folding and faulting of the North Coastal Range and the unstable soil mantle create natural conditions with high erosion potential.

Range management, wildlife habitat and groundwater replenishment are the activities which beneficially utilize the water resources in the Stony Creek Hydrologic Area. Runoff from the watershed supplies the Stony Gorge Reservoir. Quality of the runoff waters to Stony Gorge Reservoir is critical to the beneficial uses of the reservoir. Irrigation is a major use of the Stony Creek Reservoir.

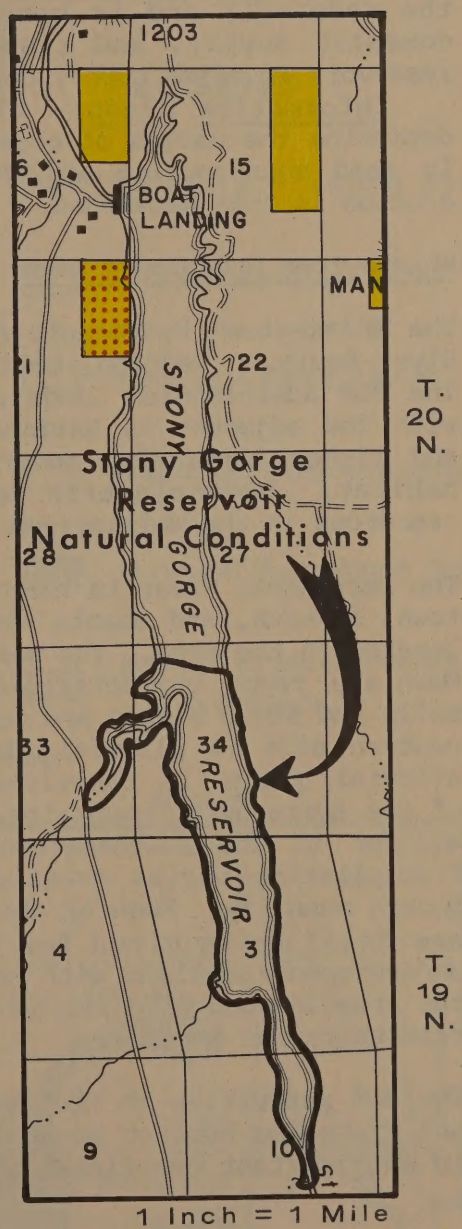
U.S. Bureau of Land Management
REDDING DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

STONY GORGE RESERVOIR

Stony Creek Hydrologic Area



R. 6 W.



LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- Bureau of Reclamation Withdrawals

Diablo Base and Meridian

Figure 3-29

Natural Pollution

Stony Gorge Reservoir (Existing)

The upper watershed of the Stony Gorge Reservoir in Glenn County adjacent to the Mendocino National Forest is drained by Stony Creek. BLM administered lands are scattered in the higher elevations of the watershed.

Sedimentation and erosion are evident both in Stony Creek and the reservoir. Runoff from winter rains accelerate sedimentation and turbid conditions. The soils in the area are shallow and highly erodible. Road construction and grazing have the potential to generate increases in erosion and soil movement. Portions of the watershed have steep slopes which naturally prohibit grazing and often are not grazed. These areas are of concern in road placement and construction as they have the highest potential for erosion.

Effect On Beneficial Uses: The Stony Creek watershed produces water for the reservoir and is beneficially used for recreation, agricultural, domestic supply, and fisheries. Sedimentation is detrimental to the reservoir in terms supply capacity and the fishery.

Information Needs: Closer evaluation of conditions is needed to determine the causes of erosion. BLM should closely monitor its activities in road construction and grazing because of the potential to accelerate erosion in this watershed.

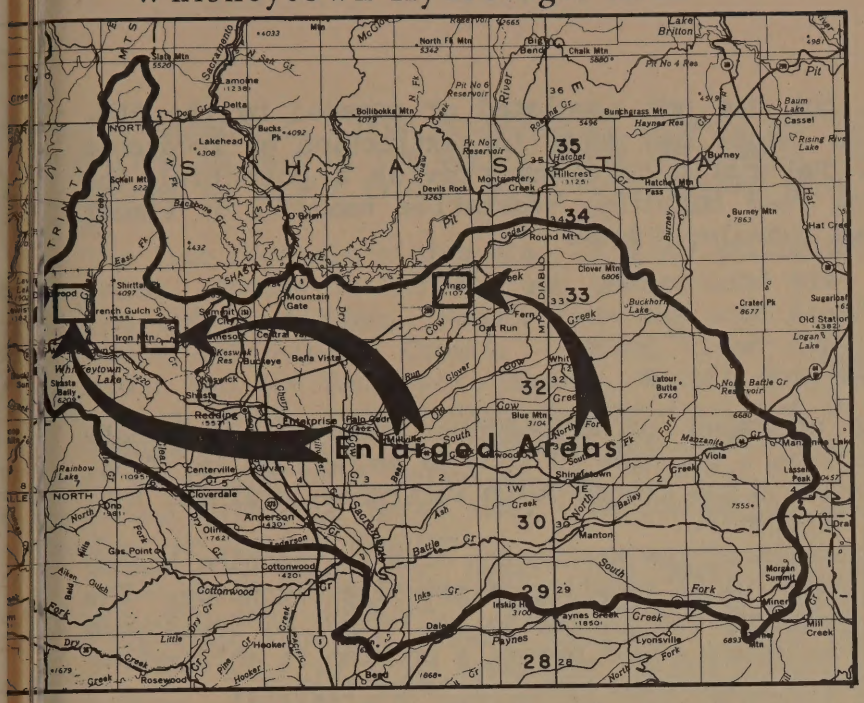
Whiskeytown Hydrologic Area

The Whiskeytown Hydrologic Area is in the upper portion of the Sacramento River Basin. Redding, California is in the center of the Hydrologic Area. The BLM administered lands are scattered throughout the area, intermingled with and adjacent to National Forest lands. Mining, grazing, recreation, and timber harvesting occur here as well as providing wildlife and fish habitat. Hydroelectric power generation is a major use of the water resources in the Whiskeytown Hydrologic Area.

The Sacramento River is the major drainage in the Hydrologic Area. Whiskeytown, Keswick, and Shasta Reservoirs are major hydroelectric dams which are located in the area. The western portion of the area is part of the Klamath Mountain range characterized by complex folding and faulting. Unstable soils and steep slopes are common on the western side of the area, while the eastern side is alluvial plain associated with the Sacramento River. The alluvial plain is comprised of the unconsolidated sedimentary material of the surrounding mountains. Groundwater is available in the Redding basin aquifer in the southeastern portion of the Whiskeytown Hydrologic Area. Precipitation varies greatly throughout the area ranging from 20 to 60 inches annually. Much of the area has been mined in the past and some areas are still being mined for locatable minerals. The area is principally undeveloped rangeland with some urban development around Redding. Much of the area is good wildlife habitat, with warm and cold water fisheries in the reservoirs and streams.

The BLM activities in the Hydrologic Area include range, wildlife habitat, and fisheries habitat management. Recreational use of the water resources is an important beneficial use in the area. Some of the mining operations

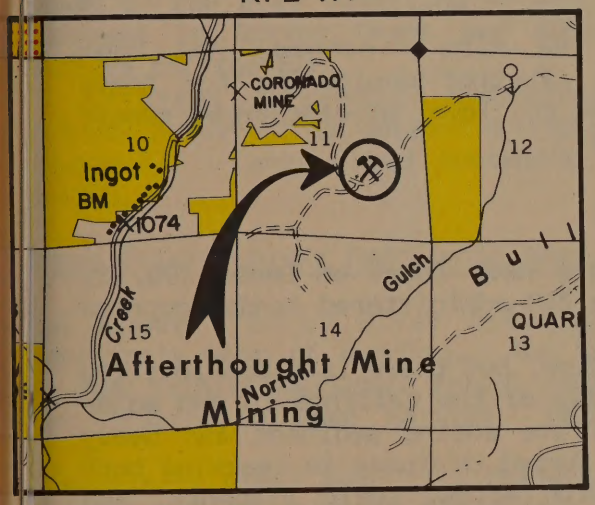
Whiskeytown Hydrologic Area



U.S. Bureau of Land Management
REDDING DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

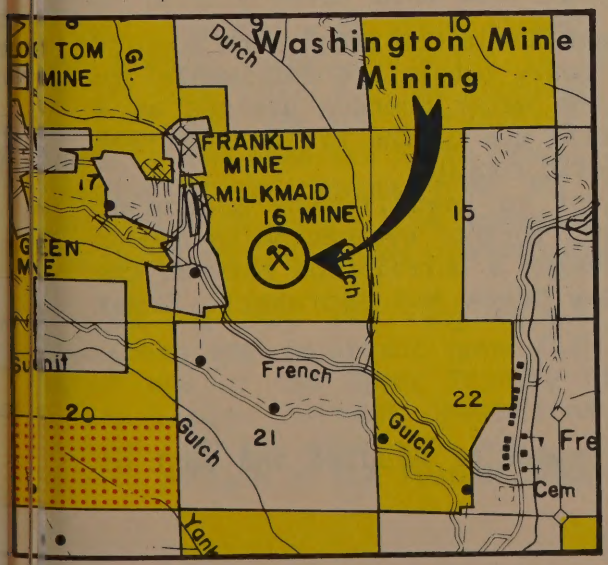
WASHINGTON MINE, IRON MOUNTAIN & AFTERTHOUGHT MINE

R. 2 W.



T. 33 N.

R. 7 W.



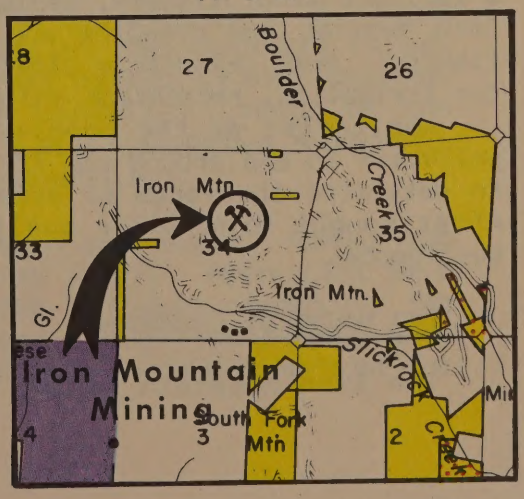
T. 33 N.

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands
- National Recreation Area
- Bureau of Reclamation Withdrawals

1 Inch = 1 Mile

R. 6 W.



T. 33 N.

T. 32 N.

Diablo Base and Meridian

Figure 3-30

are located on BLM lands, but are not regulated or managed by the BLM. Present mining operations no longer use water for extraction of locatable minerals as in the past. Natural conditions provide a potential for sedimentation resulting from road building, vegetative removal, or timber harvesting in the Whiskeytown Hydrologic Area.

Mining

Washington Mine (Existing)

The Washington Mine is northwest of Whiskeytown Reservoir in Shasta County and is presently inactive. The mine is located in Section 16, T33N, R7W, on BLM administered lands, in the French Gulch watershed, draining into Clear Creek and Whiskeytown Reservoir.

Acid drainage from the tunnels of the Washington Mine is reaching French Gulch. Copper and zinc have shown up in sampling of the mine discharge. The drainage from the mine is yearlong and is having an impact on downstream waters. Accumulations of heavy metals could become a problem in Whiskeytown Reservoir and Clear Creek, which supports a resident trout fishery.

Effect On Beneficial Uses: The effect of mine drainage in the French Gulch area on the receiving waters of Clear Creek and Whiskeytown Reservoir is detrimental to the fisheries.

Information Needs: Monitoring of the mine discharge has been accomplished by the State of California. Further monitoring for heavy metals in Clear Creek is needed to determine the level of effects of runoff from the Washington Mine on receiving waters.

Afterthought Mine (Existing)

The Afterthought Mine is east of Redding near Ingot on Route 299, in Sections 10, 11, & 15, T33N, R2W, MDM. The BLM administered lands comprise 40-50% of the land in the immediate area.

The Afterthought Mine is presently inactive, but there is a possiblility that the mine will reopen. The exposed soils of the tailings in and adjacent to Norton Gulch and Little Cow Creek are adding sediment and heavy metals to these water courses from runoff. Tunnel drainage is reaching both drainages and contains zinc and copper, with acids, toxic elements, and other metals also possible. Water generated from the Afterthought drains into Norton Gulch and Little Cow Creek and on to Cow Creek and the Sacramento River.

Effects On Beneficial Uses: Cow Creek and Little Cow Creek both support a resident trout fishery. Sedimentation and heavy metals are detrimental to fish habitat and breeding and can render the water courses useless as a fishery. Both pollutants affect the beneficial use of the Little Cow Creek for irrigation, recreation and possible domestic supply.

Monitoring of the problem is sufficient to identify the source of pollution in and around the Afterthought Mine; further evaluation is needed to determine the range of effect and to develop a correlation between the Afterthought Mine water quality of the Cow Creek and Sacramento River confluence.

Iron Mountain (Existing)

The Iron Mountain mining area is northwest of Redding and east of

Keswick Reservoir. Iron Mountain is located in T33N, R6W, Sections 34 and 35 MDM and is part of the Spring Creek watershed. BLM lands in the area are scattered in small tracts and intermingled with Bureau of Reclamation lands.

The Iron Mountain mining area is mined extensively for various locatable minerals. Mining is surface and underground with large areas of exposed tailing and overburden. Runoff from the area drains into Spring Creek via Slickrock and Boulder Creeks. Spring Creek flows directly into Keswick Reservoir and the Sacramento River. Runoff from the Iron Mountain area is picking up acids, heavy metals and sediment and is affecting water quality in Keswick Reservoir. The problems predominate during winter rainy season. Heavy metal and acid pollution are critical to water quality in terms of fishable, swimmable water use. Sedimentation has resulted in turbidity problems in Keswick Reservoir.

Effects On Beneficial Uses: The beneficial uses of Spring Creek are minimal and have generally been eliminated because of historic pollution from the mine runoff. Keswick Reservoir, which receives water from Spring Creek, is beneficially used for flood control, hydroelectric power generation, fishery and recreation. Iron Mountain mine runoff is affecting the fishery and recreational use. The possibility of Bureau of Recreational lands in the area reverting to BLM administration would make water quality problems in Spring Creek and Keswick Reservoir a significant management problem for the BLM.

Information Needs: Monitoring of the Spring Creek watershed and Keswick Reservoir is currently ongoing. No further monitoring is anticipated presently. Control and abatement of the source of pollution is what is needed.

Upper Trinity River Hydrologic Area

The Upper Trinity River hydrologic area is located in north central California west of Redding. The Upper Trinity River area is predominately in the Trinity National Forest with some BLM administered lands, utilized for grazing, timber harvest, recreation, mining, and wildlife habitat.

The Trinity River and Clair Engle Lake are the major hydrologic features of this area. The Trinity River is a major tributary of the Klamath River and is extremely important water resource for salmonids and recreation. The Upper Trinity River area was historically mined by dredging. The area is heavily faulted with steep slopes. The Upper Trinity River area is part of the Klamath Mountians which is an uplifted plateau surface on extremely varied rock types and has resulted in complex drainage patterns. The rocks in the area include metasedimentary, metamorpic, and granitic types. Soils in the area are often granitic and many areas subject to mass wasting. Precipitation ranges from 60 to 80 inches annually. Most of the precipitation occurs from November through March, with occasional showers in the other months. Snow predominates at higher elevations.

Spring and fall run king salmon, silver salmon, and winter, summer run steelhead are important game fish of the Trinity River. Recreation is a major use of the Upper Trinity River area, with the main commercial use being timber harvest operations. Water based recreation brings many people into the area each year. Quality fisheries and wildlife account for a good portion of the recreational demand.

The BLM beneficially uses the water resources of the Upper Trinity River area for range management, recreation, fishery habitat and wildlife habitat. The BLM has a few recreational facilities along the Trinity River. The Trinity River is an important water resource for various uses in the hydrologic area, but recreation and fishery habitat are the major uses where water quality is a significant factor.

BLM activities are important in the effect on water quality of the Upper Trinity River hydrologic area since much of the BLM lands are in the tributary watersheds and directly effect the Trinity River.

Brock Gulch (Existing)

The Brock Gulch road is located T34N, R11W, Sections 21, 22, 23. The area is a couple of miles north of the Trinity River adjacent to the Trinity National Forest boundary.

The Brock Gulch road is constructed in steep forested terrain on predominately decomposed soils. Heavy winter rains have caused washouts, slides, and headcutting in the Brock Gulch area due to the location of the road. Improper culvert installation in 12 places is causing headcuts. Culverts were installed above the natural channel with risers well above the inlet channel. No energy discipators were installed and incorrect culvert size has produced washouts and accellerated erosion. Unnaturally high sedimentaton and turbidity in Brock Gulch and the East Fork Trinity River during winter runoff resulted from erosion attributable to the Brock Gulch road.

Logging along Brock Gulch has destroyed riparian habitat and removed overstory along the creek. Skid trails in the creek have caused redirection of flow and increased sedimentation. The lack of buffer zones adjacent to the creek and disturbance of riparian vegetation and bank integrity has resulted in sedimentation and thermal problems. Nutrient loading and BOD problem's may occur due to poor logging practices along Brock Gulch.

Effects On Beneficial Uses: The Trinity River and its tributaries are beneficially used for; recreation, fishery and to a limited extent, domestic supply. The Trinity River is classified by the State of California as wild and scenic, supports salmon and steelhead fishery, has heavy contact and noncontact recreation, and high aesthetic value. Sediment and turbidity detrimentally effect the Trinity River.

Information Needs: Monitoring of sediment yield and flow on Brock Gulch and the North Fork Trinity River would identify the magnitude and degree of effect Brock Gulch has on the East Fork of the Trinity River. Measures are needed to prevent headcuttting, glory holes, and washouts from the Brock Gulch road. Evaluation of future timber harvesting plans to insure that water quality and stream integrity are adequately protected is needed.

Low Volume Roads

Conrad Gulch (Existing)

The Conrad Gulch road is located in T34N, R10W, Sections 17, 18, 19, and 20 MDM. The area is on Tunnel Ridge up the Canyon Creek drainage approximately four miles from the Trinity River. The BLM administered lands are adjacent to the Trinity National Forest.

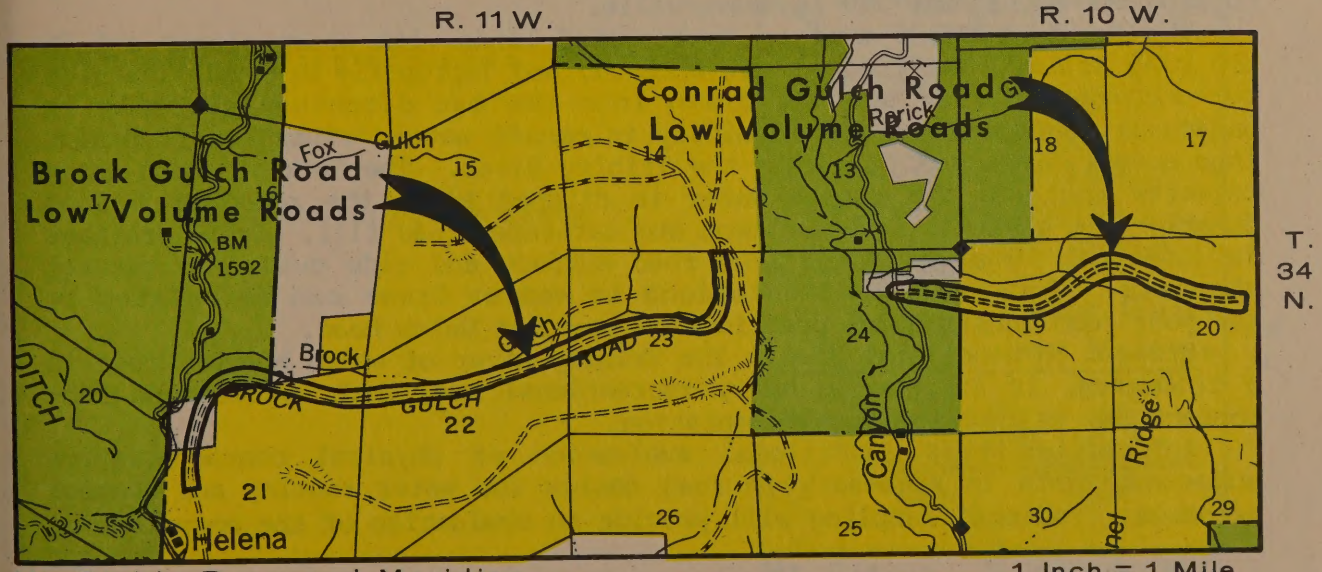
U.S. Bureau of Land Management
REDDING DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

BROCK GULCH ROAD & CONRAD GULCH ROAD

Upper Trinity River Hydrologic Area

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands



Mt. Diablo Base and Meridian

Figure 3-31

The Conrad Gulch road was constructed in conjunction with a timber harvest operation in the area and now maintained for access into the area. The area has steep slopes and has experienced massive slides since construction of the Conrad Gulch road. Poor road location, toe cuts, runoff water saturation, and unstable soil conditions are all factors involved in the massive soil movement. Insufficient cross drainage culverts have lead to fill material saturation and sedimentation from road surface runoff. The massive soil movement has increased erosion and subsequent sedimentation in Conrad Gulch and downstream waters of Canyon Creek and the Trinity River.

Effects on Beneficial Uses: The Canyon Creek area is used for recreation, fishery, and aesthetics with sedimentation detrimentally impacting these uses. The Canyon Creek road receives intensive recreational traffic and aesthetics is an important aspect of Canyon Creek.

Information Needs: Strict evaluation of road placement criteria and soil conditions is needed. Also an evaluation of runoff capacity routing for the Conrad Gulch road is needed.

Douglas City Campground Road (Potential)

The BLM Douglas City campground road is located in T32N, R10W, Sections 1 and 12. The area is just west of Douglas City along the Trinity River.

There has been massive soil movement along this road, with the potential for increased erosion and sedimentation. A thrust fault in the area of the Douglas City campground road suggests the potential for mass soil movement. No evidence of increased sedimentation in the adjacent Trinity River has been documented.

Effects on Beneficial Uses: Beneficial uses in the area which would be affected by increased sedimentation and turbidity in the Trinity River would be the fishery, recreational use, domestic supply, and aesthetics. The magnitude of effect slides can have on water quality is impossible to determine until they occur.

Democrat Gulch (Existing)

The Democrat Gulch road is located in T33N, R10W, Sections 12 and 13. The area is west and south of Weaverville, California. Access is gained by turning off of highway 299 in Weaverville.

The Democrat Gulch road is in forested lands with steep slopes and in red clay soils. The road is not surfaced and improperly drained. The side cut slopes and road surface drain into the bar ditching resulting in unnatural sedimentation and turbidity in runoff water. This runoff drains into Weaver Creek and then into the Trinity River. The lack of cross drain culverts contains the runoff water in ditches along the road for a long duration, it then picks up sediment and saturates road fill. Cross drainage is important to move runoff from road surface and side cuts into natural channels. Increased sedimentations in Weaver Creek can be related to the poor road construction practices on Democrat Gulch Road.

Effects on Beneficial Uses: The Trinity River of which Weaver Creek is a tributary, is subject to heavy recreational use, both contact and non-contact and is impacted by sedimentation.

Information Needs: Additional evaluation of physical characteristics and constraints is necessary in road design for water routing and control measures. Sediment sampling will provide an evaluation of the magnitude of

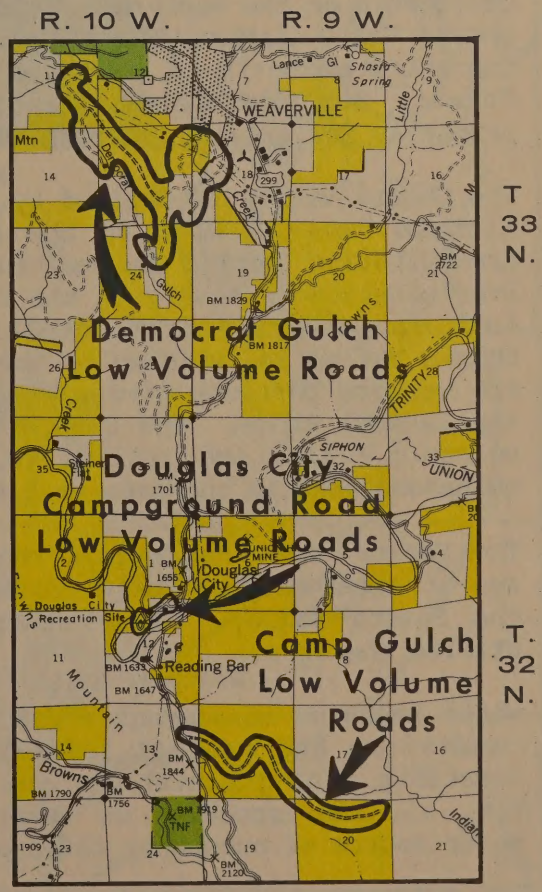
U.S. Bureau of Land Management
REDDING DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

DEMOCRAT GULCH, CAMP GULCH & DOUGLAS CITY CAMPGROUND ROAD

Upper Trinity River Hydrologic Area

LEGEND

- Existing Problem Area
- Potential Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands



Mt. Diablo Base and Meridian

½ Inch = 1 Mile

Figure 3-32

the Democrat Gulch sedment situations in relation to its downstream receiving waters.

Camp Gulch (Existing)

The Camp Gulch road is located in T32N, R9 W. Section 18. The area is along Reading Creek south of Douglas City, California and the Trinity River.

The Camp Gulch road was constructed to provide access for a timber sale in the area. The road is maintained for recreational access to the area. There has been slippage and massive soil movement in relation to the Camp Gulch road and sedimentation has occurred in Camp Gulch. Lateral displacement from faulting is the probable cause for massive soil movement. The Camp Gulch road compounds the soil movement problems which occur naturally in this area.

Effects On Beneficial Uses: Camp Gulch is a tributary of Reading Creek and in turn the Trinity River. Recreational use of this system is the major beneficial use, with fisheries and aesthetics also important. Sedimentation from Trinity River tributaries can have detrimental effects on its uses.

Information Needs: Monitoring of Camp Gulch and receiving waters would provide cause and effect relationship between the Camp Gulch watershed and receiving downstream waters.

Shasta Valley Hydrologic Area

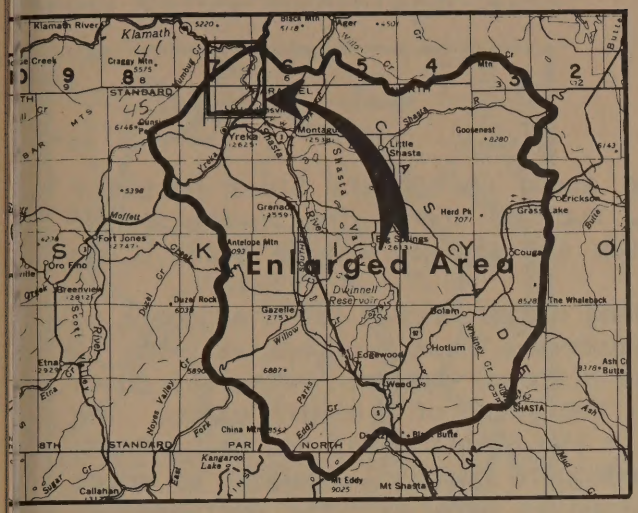
The Shasta Valley Hydrologic Area is located in the central part of Northern California on the western side of the Cascade Range and north of Mt. Shasta. Shasta Valley is predominately private land with the BLM administered lands concentrated north of Yreka, California adjacent to the Klamath National Forest. BLM administered lands in this Hydrologic Area are utilized primarily for grazing, mining, and wildlife habitat.

The Shasta Valley is drained by the Shasta River, which runs north into the Klamath River. Flow in the river is sustained past the main winter precipitation period by melting snowpack of the surrounding mountains. Precipitation is mostly in the form of snow and varies from 15 to 25 inches falling primarily from October through March. The eastern portion of Shasta Valley is typified by the Klamath Mountain geomorphic province while the western portions give way to Tertiary and Quaternary volcanic rocks of the Cascade Range. The Shasta Valley is characterized by alluvial plains, volcanic hills, and rolling recent basaltic lava flows. Groundwater is quite abundant in the area east of Shasta Valley.

The Shasta River has a fall run of king salmon, silver salmon, and winter run of steelhead. Blacktailed and mule deer are common big game species in the Shasta Valley. Many other water oriented small game and waterfowl utilize the area.

Water resource management efforts by the BLM have been to maintain natural conditions and protect fisheries habitat. Historical and present day locatable mining operations in the area are not directly managed by the BLM, although occuring on federal lands. Mining claims account for the major source of occupancy cases on the federal lands in this area.

Shasta Valley Hydrologic Area



U.S. Bureau of Land Management
REDDING DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

GOLD BAR & SHASTA RIVER

LEGEND

- Existing Problem Area
- Suspected Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands

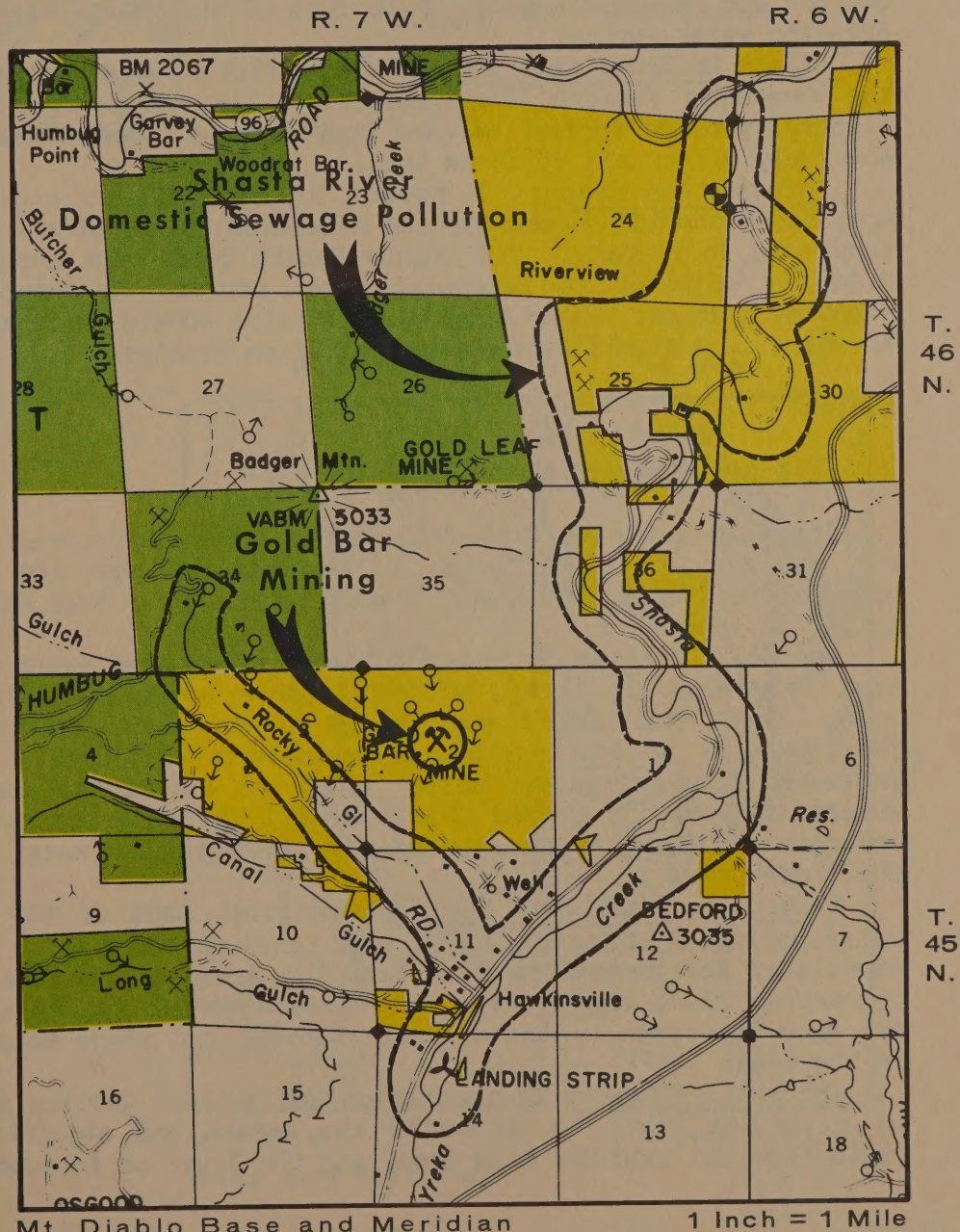


Figure 3-33

Domestic Sewage Pollution

Shasta River (Suspected)

BLM administered lands are scattered along the Shasta River north of Yreka, California and along Yreka Creek. Much of the mining in the Shasta River Valley has occured in the Riverview and Pioneer Bridge areas along the Shasta River.

Scattered occupancies, related to mining claims on BLM lands adjacent to the Shasta River are a water quality concern. These occupancies, due to their temporary nature, often have sewage disposal systems. Many of these dwellings are in trespass and exist under the guise of a mining claim. The close proximity of many of the dwellings to the Shasta River and Ureka Creek would allow bacterial pollution from inadequate disposal systems to enter the water courses. This bacterial pollution is hazardous for recreational contact and domestic supply. Also some of the Shasta River is utilized as a drinking water supply.

Effect On Beneficial Uses: The beneficial uses of the Shasta River and the receiving Klamath River support an important anadromous and resident fishery, provide recreation, and provide some domestic supply. Sewage will adversely effect all of these uses.

Information Needs: A review of land status and checks of mining operations should be completed to determine if any of the occupancies on BLM lands are in trepass. The County Health Department should check dwellings along or adjacent to perennial water courses to insure adequate sewage disposal systems. Water quality monitoring should be initiated to determine if there is a significant sewage pollution problem.

Mining

Gold Bar Mine (Existing)

The Gold Bar mine along the Shasta River is located in Section 2 T45N R7W MDM are north of Yreka, California. There are intermittent BLM administered lands along the Shasta River. The Gold Bar mine is located on public lands.

The Gold Bar mine has numerous areas of exposed soils and tailings. The area is drained by Rocky Gulch and there are quite a few springs in the area. Water from runoff and springs flowing over or through these exposed tailings pick up sediment and other chemical elements. Sedimentation and increased total dissolved solids (TDS) can effect the downstream receiving waters of Yreka Creek and Shasta River. The numerous springs in the area indicate the Rocky Gulch watershed is an important water supply source for the Yreka Creek.

Effect On Beneficial Uses: Beneficial uses of the Yreka and Shasta water courses are recreation and fishery habitat. Sedimentation is especially detrimental to fish breeding areas and to the desirability for recreation along the river. Water resources of the Rocky Gulch watershed are also important to the wildlife habitat and range management activities in the area.

Information Needs: Sedimentation and general quality sampling is needed on a regular basis to determine the extent and significance of sediment yield from the Gold Bar mine area, and the level of influence Rock Gulch has

Scott Valley Hydrologic Area

U.S. Bureau of Land Management
REDDING DISTRICT
WATER QUALITY PROBLEM ASSESSMENT

BLUE POND

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)

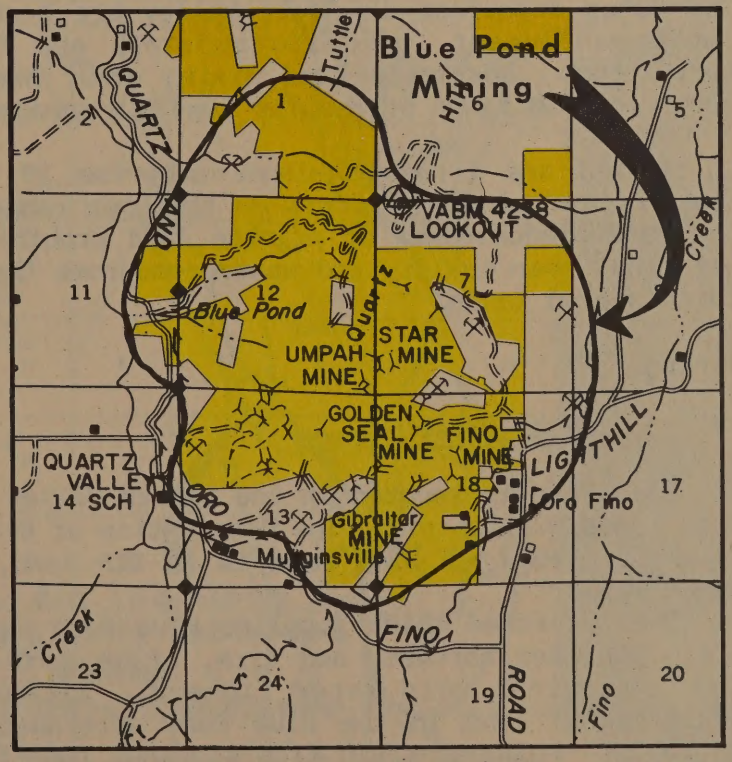


Figure 3-34

on the downstream receiving waters. Sampling is needed to determine if any possible heavy metal pollution is cocuring from the mined areas.

Scott Valley Hydrologic Area

The Scott Valley Hydrologic Area is located in the north central portion of California and lies on the eastern side of the Klamath Mountains. The Scott Valley is predominated by private lands and is adjacent to the Klamath National Forest. The BLM administered lands are scattered within the Hydrologic Area, and are utilized for grazing, timber harvesting, mining, wildlife habitat and fish habitat.

The Scott River drains the Scott Valley and is a tributary of the Klamath River. Historically the Scott River and its tributaries were mined by dredging. Presently the predominant use in the area is farming, ranching and some mining. Precipitation occurs from October to March with the valley recieving 15 to 25 inches annually. The higher elevations recieve most of the annual precipitation in the form of snow, with runoff from snowmelt sustaining streamflow into the summer months. The Scott Valley is predominantly alluvial plains and the western portions developed by erosion of an uplifted plateau. Many drainages cut through benches covered with terrace gravels, some have proven to be gold-bearing. The alluvium in this area is considered suitable for groundwater development.

Fall run king salmon, silver salmon, and winter steelhead spawn in the Scott River and its tributaries. Mule deer, bear, and lion are the major big game species in the Scott Valley as well as many furbearers and game birds.

The water resources in Scott Valley are beneficially used by the BLM for range management, wildlife habitat, and fisheries habitat and timber harvesting. Recreation and mining occur here but very little of the use occurs on BLM lands or results from BLM management activities.

Cultivated and irrigated lands comprise 20 percent of the Scott Valley. Grazing predominately occurs on the open range lands. The scattered federal land and predominance of private land prohibits the BLM from significantly altering water quality and water resources though its management of the BLM administered lands.

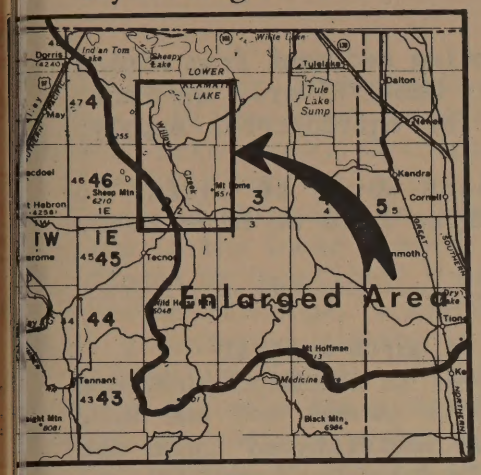
Mining

Blue Pond (Existing)

Blue Pond is located in the Quartz Valley south of the Scott River near Fort Jones, California. The description of Blue Pond is T43N R10W, Sections 11 & 12. Half of Blue Pond is on BLM land, the other half on privately owned land.

The watershed which supplies Blue Pond has had extensive land use from mining, timber harvest, and fire. Blue Pond supports a warm water fishery and a marginal cold water fishery. Extensive mining activity on BLM administered land in the Blue Pond watershed has left exposed slopes and tailings. Sediment yield from seasonal runoff of winter storms collects in Blue Pond and is impacting its water quality.

Upper Klamath River
Hydrologic Area

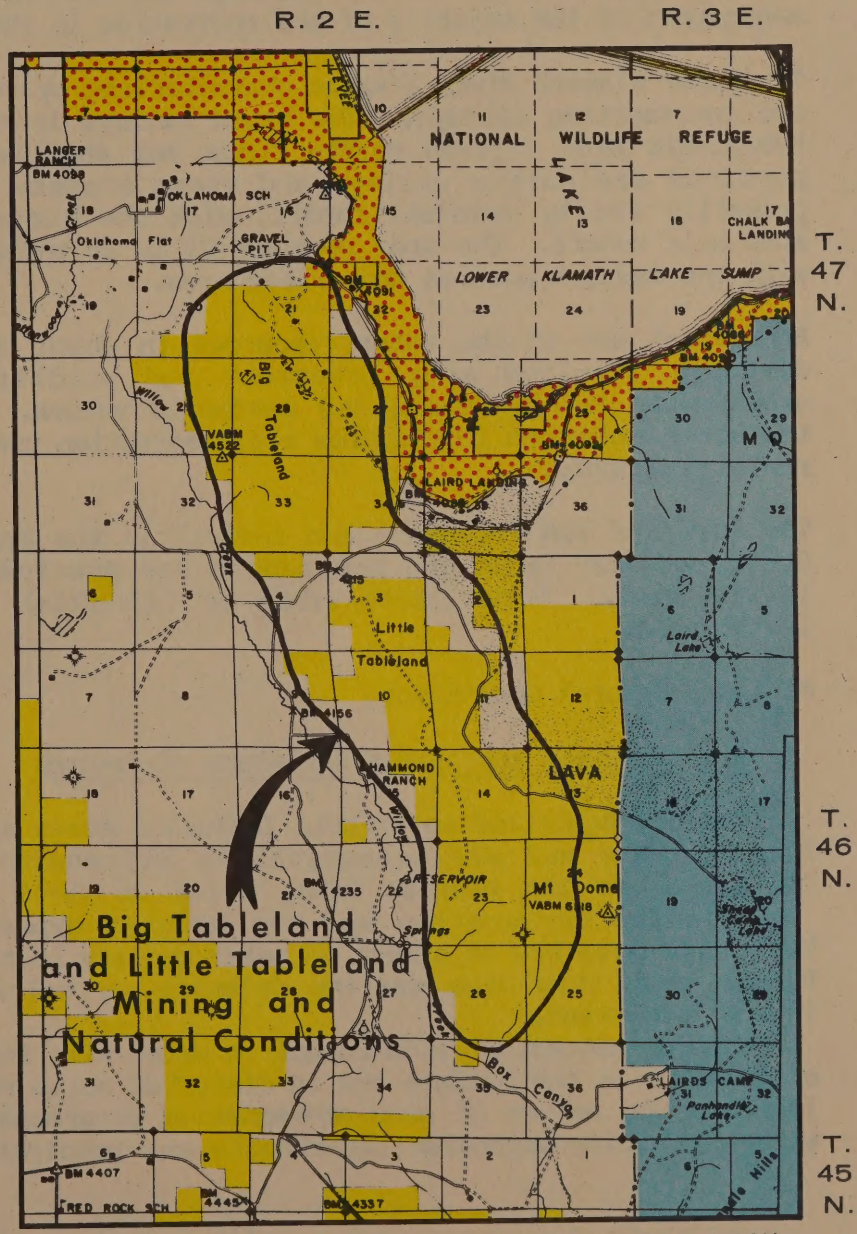


U.S. Bureau of Land Management
REDDING DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

BIG TABLELAND & LITTLE TABLELAND

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands
- Bureau of Reclamation Withdrawals



Mt. Diablo Base and Meridian ½ Inch = 1 Mile

Figure 3-35

Effect On Beneficial Uses: Blue Pond is preventing sediment from mining activities from reaching Mill Creek and subsequently Scott River. The Scott River is important as a anadromous fishery, and for agricultural supply, sediment is detrimental to both uses.

Information Needs: Sediment yield estimations would be useful to evaluate the extent of impact the mining activites have on Blue Pond.

Upper Klamath River Hydrologic Area

The Upper Klamath River Hydrologic Area is located in north central California along the Oregon border. The Klamath River is the major drainage in the area. Land ownership is mixed with private owners and the U.S. Forest Service being the major land holders. BLM administered lands are scattered throughout the Hydrologic Area. The Red Rock Valley area contains the only significant block of BLM land. Activities occurring on BLM land are mining, grazing, and timber harvesting. Recreation is a major use of the upper Klamath River, although the BLM is not directly involved in management of the majority of the recreation in the Hydrologic Area.

The Upper Klamath River area is characterized by rugged, irregular mountains and intersecting valleys. The broad valleys in the eastern portion of the Hydrologic Area contain marshy sumps and shallow lakes while the western portions are narrow valleys and steep slopes. The stream systems are primarily fed by rainfall runoff, with the higher elevations contributing snow melt runoff. The area receives 12 to 25 inches of annual precipitation with the eastern portion the driest area.

Beneficial use of the water resources in which BLM resource management is directly involved are; livestock and wildlife watering, fisheries, groundwater replenishment, and aesthetic values. Other beneficial use of the water resources in the area are; recreation use, irrigation, and limited municipal supply.

The level of BLM influence and control in the Hydrologic Area is minimal. Scattered BLM lands and remoteness has precluded intensive management in the past. Very little urban or industrial development has occurred in the area.

Mining - Natural Conditions

Big Tableland and Little Tableland (Existing)

The Big Tableland and Little Tableland areas are southwest of the Lower Klamath Lake and are predominately BLM administered lands. Dorris, California is the nearest town, which is 10-12 miles to the northwest.

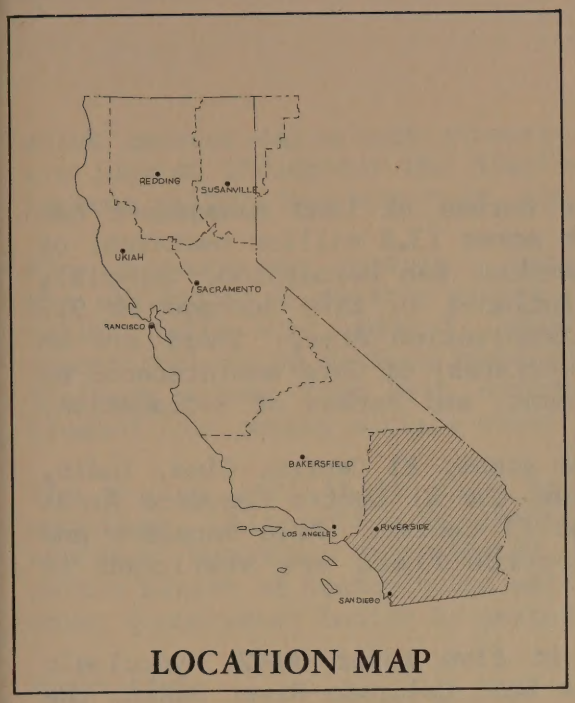
Dolemite exploration and the natural exposure of dolemite in the Tablelands area has an effect on water quality in the Willow Creek drainage. Runoff from this area carries dolemite, a calcium-magnesium bicarbonate into Willow Creek.

Calcium-magnesium bicarbonate in water will increase hardness. Exposure of dolemite to the surface and in disturbed soils resulting from mining will increase the amount of calcium-magnesium bicarbonate in solution of runoff water. Calcium-magnesium bicarbonate can precipitate out of the water if

correct soil or atmospheric conditions exist, leaving a chalklike white residue. Willow Creek is a major groundwater recharge source in the Lower Klamath Lake area. Calcium-magnesium bicarbonates from Willow Creek infiltration may be effecting groundwater in the basin. The natural abundance of dolemite in the area is the source of the white precipitate visiable in the Lower Klamath Lake area.

Effects On Beneficial Uses: The major beneficial use of Willow Creek is groundwater recharge, wildlife and livestock water. Dolemite mining could effect groundwater quality in the basin.

Information Needs: A monitoring program should be set up on Willow Creek to evaluate the possible increases in hardness and determine whether groundwater quality would be effected. No specific monitoring of water quality occurs on Willow Creek presently. Mining procedures should be checked for proper stockpiling and rehabilitation of spoils.



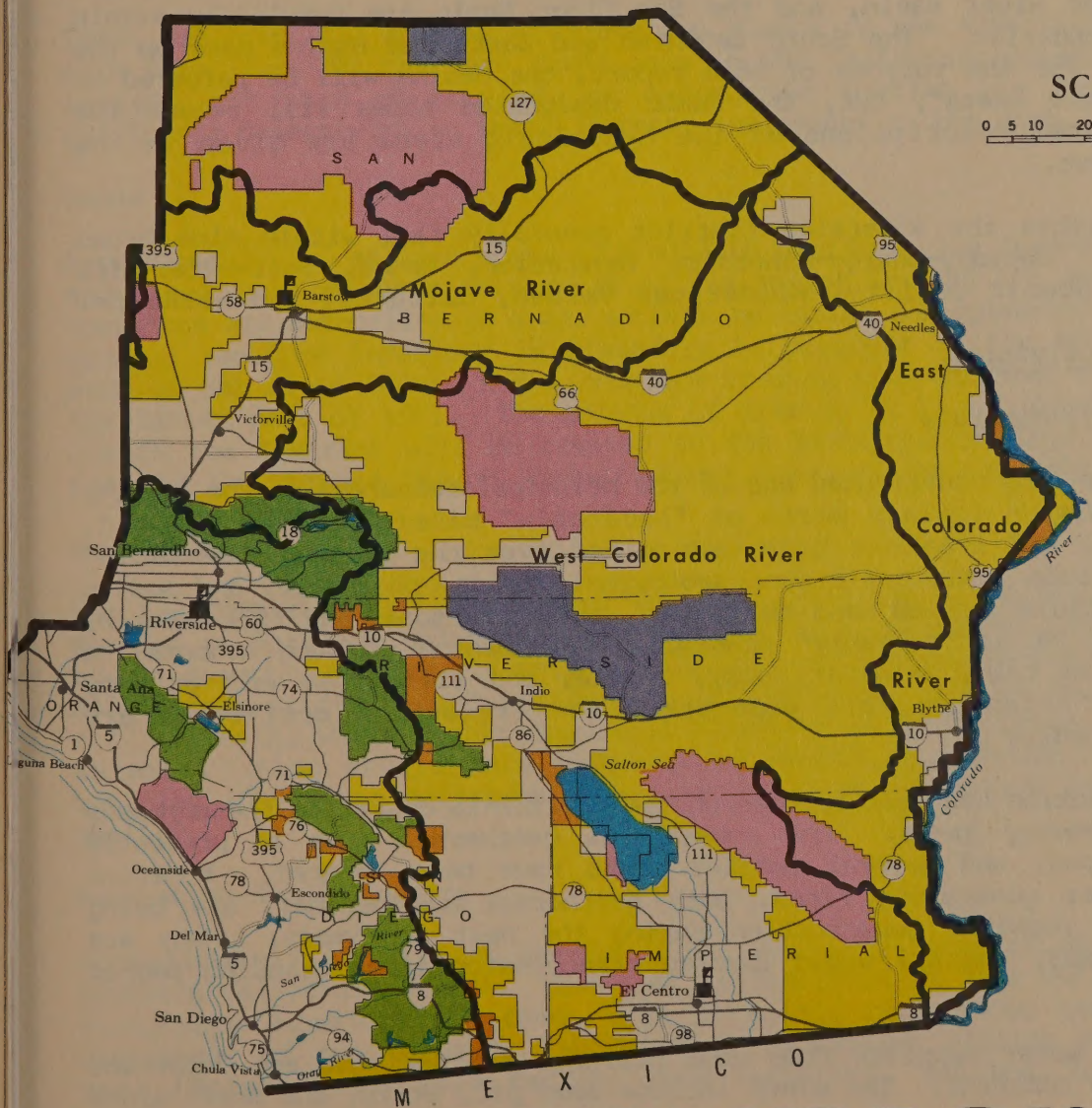
LOCATION MAP

LEGEND

- Public Lands
- National Forests
- National Parks and Monuments
- Military Reservations
- Indian Reservations
- BLM Office
- BLM District Boundary
- Hydrologic Area Boundary

SCALE

0 5 10 20 30 40 50 Miles



RIVERSIDE DISTRICT

Figure 3-36

RIVERSIDE DISTRICT

The Riverside, California District of the Bureau of Land Management has jurisdiction over approximately 9.4 million acres (3.8 million hectares) of public land within the boundaries of Riverside, San Bernardino, Imperial, and San Diego Counties (Figure 3-36). Included in this acreage is 9.2 million acres of the California Desert Conservation Area. There are an additional 4.5 million acres (1.8 million hectares) of land administered by the National Park Service, Defense Department, and Bureau of Reclamation.

The District is divided into four resource areas: El Centro, Cima, Indio, and Barstow (Figure 3-36). The Barstow and the El Centro Resource Areas have administrative offices in Barstow and El Centro. Area managers and their staffs of the Indio and Cima Resource Areas are stationed in Riverside.

The Riverside District administers land in five major SWRCB hydrologic basins (Figure 3-36). Three of these, the West Colorado River Basin, the East Colorado River Basin, and the San Diego Basin are completely within District boundaries. The South Lahontan and Santa Ana Basins make up the other two. For the purpose of this report, the basins will be referred to as "hydrologic areas", but, the SWRCB designated names will remain the same. General descriptions of the hydrologic areas are given in the following text.

Resources within the Riverside District generally fall within nine broad categories: Geology-Energy-Minerals, Vegetation, Range, Soil-Water-Air, Recreation-Scenic Quality, Wilderness Values, Cultural, and Wildlife.

Management Activities

Geology-Energy-Minerals

Minerals have long constituted one of the principal resources of the desert. Many millions of dollars worth of "locatable" minerals, such as gold, silver, zinc and iron ore have been mined over the years. "Leasable" minerals include coal, petroleum, geothermal fluids, phosphate, and sodium salts. Materials such as sand and gravel, building stone, and fill material are referred to as "saleable" minerals. The mining of such nonmetallic commodities as talc, feldspar, clay, borate, and silica, as well as many "rare earth" elements, are widespread and extraction activities are spreading rapidly.

National attention has been focused on the California desert as the emphasis on planned energy grows. One substantial geothermal area is presently being developed, and several smaller sites have been located. Numerous proposed power generating sites, both geothermal and nuclear, are being analyzed for possible construction during the next ten years. Many are on public lands, and all would involve transmission lines crossing public lands.

Pollution of water supplies from mine drainage and sediment are important water quality concerns. The mines include open pit, strip, and shaft mines

which uncover calcareous minerals, heavy metals, and alluvium. The mines are located throughout the district, but the most noteable ones are in the Lucerne Valley, Mountain Pass, the Picacho area, Boron, and Banner.

Mine drainage may contain a great amount of sulfuric acid produced from the oxidation of pyritic materials. As a result, mine drainage is often called "acid mine water." Mine drainage is also characterized by high concentrations of various heavy metals, many of which are toxic. The mine drainage arises from both underground and surface mining sources and is flushed into nearby surface water as "slugs" during runoff events.

The mining activities also have a pronounced effect on ground-water supplies. Alteration of groundwater distribution patterns results in aquifers becoming contaminated from disturbed bedrock formations which permit mixing of contaminated water with good water. Also mine drainage can enter groundwater bodies by percolating through a recharge area.

Vegetation

There are over 700 species of flowering plants in the Riverside District, with more than 200 that are found only in the California desert. Approximately 130 rare threatened, or endangered species are found in the California desert with at least 30 being indigenous to the area.

Range

Approximately 2.5 million acres (1.0 million hectares) are leased for cattle and sheep grazing under Section 15 of the Taylor Grazing Act and sixty-two operators are authorized to graze on both perennial and ephemeral leases. A grazing resource inventory is presently in progress in the McCain Valley area of San Diego County and a complete grazing environmental study is due the latter part of 1981. The balance of grazing is in the desert area and use in the District will be covered in the Environmental Impact Statement for the California Desert Conservation Area, to be completed in 1980.

Soil-Water-Air

The California desert environment and its resources, particularly certain species of Rare and Endangered wildlife and fish, are seriously threatened by the desert's growing air pollution problem and by soil and water erosion. Soil impact studies are being done to determine the effects on erosion and soil strength, which result from soil disturbances by vehicles and grazing animals. Also studies are underway to assess the impact of off-road vehicles (ORV's) on different soil types, and the resultant impact on air quality.

Recreation-Scenic Quality

Approximately 12 million people live within a two-hour drive of the southern California desert. The area is described as "the world's largest contiguous area of dispersed, high-intensity recreation use under the management of one agency". Millions of recreation visitor use days per year include motorcycle racing, dune buggying, jeeping, sightseeing,

camping, picnicking, nature study, photography, painting, hiking, backpacking, rockhounding and sandsailing.

Wilderness Values

The California desert contains some of the most outstanding and diverse examples of desert wilderness in existence. Several of these are being considered for inclusion in the Federal Wilderness System.

Cultural

The District contains many cultural sites ranging from prehistoric to historic, and from rock rings to mining towns. Desert archaeological sites are usually fragile surface sites. Site types include, among others, rock shrines, sleeping circles, intaglios, petroglyphs, pictographs and lithic and/or ceramic scatters. Historic sites are largely associated with mining activity (providence townsites), the Military (Patton's camps), or transportation (Old Government Road).

Wildlife

The District encompasses a wide variety of habitats which support a great diversity of wildlife. There are about 450 species of vertebrates, more than 300 of which are birds. Some of the rare ones are the bighorn sheep, desert tortoise, Mojave ground squirrel, Coachella Valley fringe-toed lizard, Couch's spadefoot toad, Bendire's thrasher, Mojave chub (an endangered species), prairie falcon, roadrunner and desert kit fox.

Major programs administered from the Riverside District Office, and from resource area offices, are centered around the various resources. The large variety and extent of recreational uses, and to a somewhat lesser degree, the extensive mining operations throughout the desert area, account for the majority of major programs implemented. Lesser programs involve grazing range control, and wildlife inventory and protection.

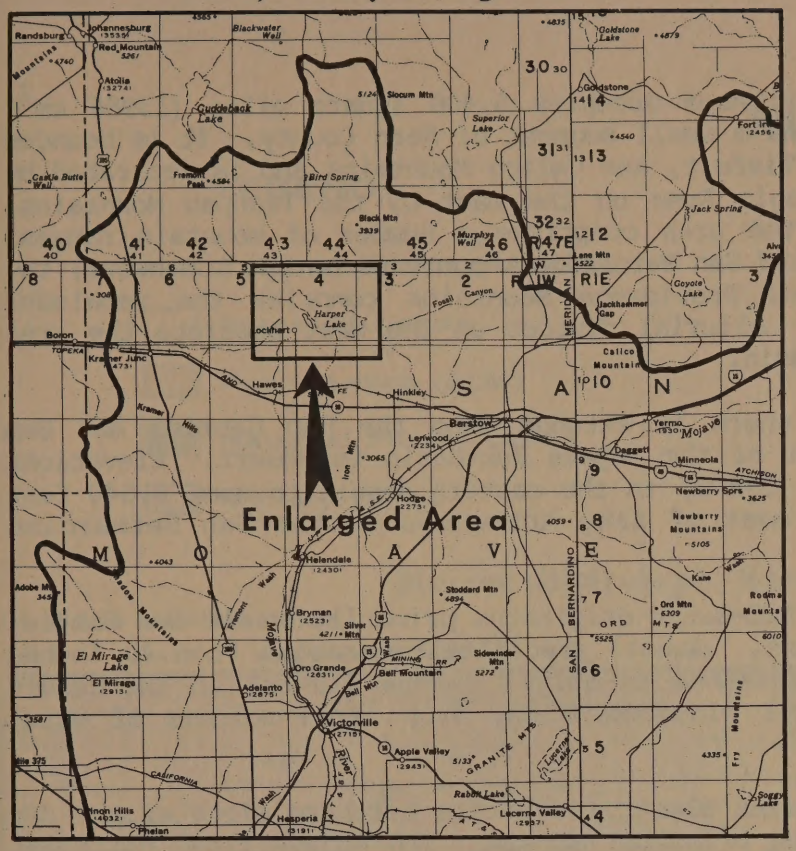
The overall object of these programs is to optimize resource usage and at the same time protect the California desert for future generations.

A district-wide water quality concern has been identified in regard to wildlife - wild burros. Wild burros concentrate near water sources throughout the desert, especially in the dryer months. Several such locations are: (1) Indian Springs, T13N, R11E, SBM and (2) Addy Spring. The burros severely trample and disturb the soil and vegetation adjacent to springs, ponds, and streams. Resulting water quality degradation is due to sediment, organic matter, and bacteriological contaminants.

Mojave River Hydrologic Area

Of the hydrologic units within the South Lahontan Basin, the Mojave River and part of the Amargosa River Hydrologic Area are within the Riverside District boundaries (Figure 3-36). Water quality concerns have been identified in the Mojave River Hydrologic Area only.

Mojave Hydrologic Area



San Bernardino Base and Meridian

½ Inch = 1 Mile

U.S. Bureau of Land Management
RIVERSIDE DISTRICT

WATER QUALITY PROBLEM ASSESSMENT

HARPER LAKE

LEGEND

- Existing Problem Area
- Patented Lands
- Public lands (BLM)

Figure 3-37

The Mojave River Hydrologic Area occupies 5,400 square miles (13986 km^2) in San Bernardino County and a small segment of Kern County. It is bounded on the north by the Soda, Tiefort, and Calico Mountains and is separated by the Amargosa River Hydrologic Area on the east by the Ivanpah Mountains. The southern boundary of the area comprises a number of mountain ranges, including the San Gabriel and San Bernardino Mountains on the southwest; the Ord, Bristol, Granite, and Providence Mountains comprise the remainder of the southern boundary. Alluvial divides on the west separate the area from Antelope Valley Sub-Basin.

Except on the southwest, where it extends into the San Gabriel and San Bernardino Mountains, most of the Mojave Sub-Basin is desert. Elevations range from about 900 feet (274 m) in the eastern desert to some 8,540 feet (2603 m) at Butler Peak east of Lake Arrowhead in the San Bernardino Mountains.

Runoff in the Mojave River Sub-Basin originates primarily in the San Gabriel and San Bernardino Mountains. Annual precipitation ranges from 40 inches (102 cm) in the higher elevations to only 4 inches (10 cm) in the desert valleys, although occasional cloudbursts may drop large volumes of water in a short time.

The Mojave River, which drains almost the entire northern slope of the San Bernardino Mountains, is the principal stream. The Mojave flows northeast for 100 miles (161 km) and terminates in Soda Lake near Baker. During rare high flows, it drains into Silver Lake farther north. The main branch of the Mojave River is formed by the confluence of Deep Creek and the West Fork of the Mojave at the foot of the San Bernardino Mountains near Hesperia. The combined average annual runoff at this point is about 79,000 acre-feet (97.5 million cubic meters) per year.

The volume of water flowing downstream in the Mojave River is decreased by diversions, percolation and evapotranspiration. Near Victorville, stream-flow in the Mojave River averages 55,600 acre-feet (68.6 million cubic meters) per year; at Barstow, annual average flow diminishes to 18,000 acre-feet (22.2 million cubic meters). Silverwood Lake, part of the state water project, is used to store water from Northern California but releases the natural flow of the Mojave River.

Several reservoirs in the San Bernardino Mountains provide all-year conservation. The largest of these is Lake Arrowhead, with a storage capacity of 43,000 acre-feet (53 million cubic meters). Additional storage is provided in Lake Gregory, Grass Valley Reservoir, and Green Valley Lake; the combined capacity of these three is 2,800 acre-feet (3.5 million cubic meters).

Groundwater in the Mojave River Hydrologic Area is stored principally in unconsolidated alluvium. The maximum depths of these water-bearing sediments is unknown; however, in the Kelso hydrologic subunit they have been recorded at almost 2,000 feet (610 m). Precipitation and surface water runoff are the principal sources of recharge.

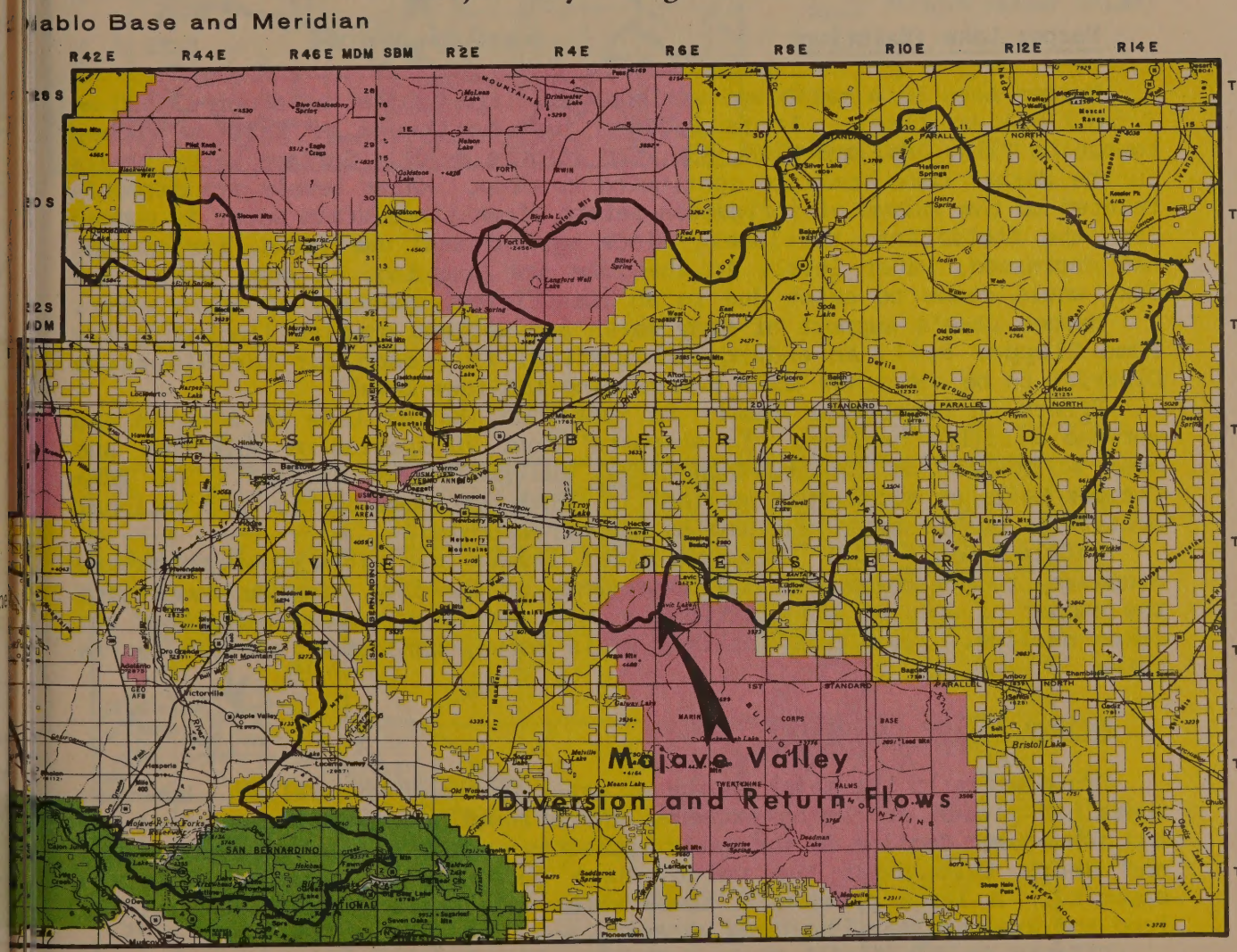
U.S. Bureau of Land Management
RIVERSIDE DISTRICT
WATER QUALITY PROBLEM ASSESSMENT

MOJAVE VALLEY

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands
- Military Lands

Mojave Hydrologic Area



Scale 1 : 1,175,000
(1 Inch = Approximately 18½ Miles)

Figure 3-38

Yields of wells range from only a few gpm to 3,600 gpm (227 lit/sec); the highest yields are from wells near the Mojave River. In 1969, depths to groundwater ranged from the surface in Harper Basin to 685 feet (209m) in the Upper Mojave Hydrologic Subunit. Groundwater is both confined and unconfined, and perched groundwater is found locally in both El Mirage and Upper Mohave Hydrologic Subunits. Storage capacity for groundwater in the Sub-Basin is about 45.5 million acre-feet (5.6×10^{10} m^3). However, in the 200 foot (61 m) zone above the bottom of the deepest well (most wells are approximately 200 feet (61 m(deep), the saturated volume (storage) is about 7 million acre-feet (8.6×10^9 m^3).

The amount of water that can be extracted annually without causing a long-time change in storage (practical sustained yield) for the Mojave Hydrologic Area is about 30,000 acre-feet (37 million cubic meters). Small amounts of groundwater flow into and out of the Mojave River Planning Area. However, these movements have an insignificant effect on water quality.

Harper Lake (Existing)

Harper Lake is a marsh and wetlands wildlife habitat of about 13,500 ac (5463 ha) in size. It is located just northwest of Barstow within townships T11N, R4W, and T11N, R3W, SBM (figure 3-38). Surface water levels in the Harper Lake area are continuing to drop. Water levels are directly related to the volume of irrigation return flows since drain water is pumped from the fields into the lake. Since agricultural use (thus, irrigation) has decreased, water levels in the lake are dropping. At some point, the lake would cease to exist due to an insufficient quantity of drain water.

Harper Lake's support of many marsh and wetland species (including the Yuma Clapper Rail, an endangered species) is reason for the Riverside District to be concerned about maintaining the lake level.

Effect On Beneficial Uses: As mentioned, Harper Lake is a marsh and wetland wildlife habitat. It supports about 70 species of waterfowl and over 50 species of raptors, songbirds, and small game animals. The Yuma Clapper Rail, an endangered species, is among the inhabitants. Recreational activities on the marsh are hunting and birdwatching.

Information Needs: Data on water levels and rates of decline are necessary to determine the life expectancy of the lake in order to predict the number of species and distribution that can be supported throughout the lakes decline. Once this information is known, management actions can be taken.

Mojave Valley (Existing)

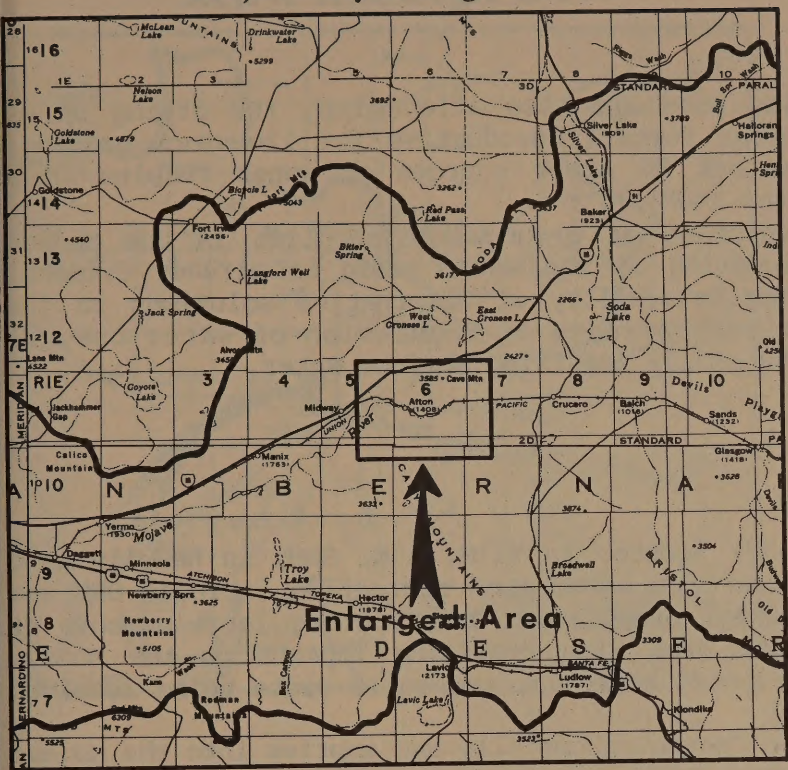
Groundwater is the major source of water in the Mojave Valley. However, sustained yields are being exceeded and a resulting groundwater overdraft and subsequent decline in the water table has occured. Many springs, wells, and seeps throughout the valley have gone dry or have a decreased capacity. A large portion of these water sources are on BLM administered land and are used for livestock watering.

Effects On Beneficial Uses: The beneficial uses of water within the Mojave groundwater hydrologic unit are minicipal, agricultural (including ranching), industrial, and freshwater replenishment. The most immediate effects are on the smaller and shallow depth wells used for domestic and

U.S. Bureau of Land Management
RIVERSIDE DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

AFTON CANYON

Mojave Hydrologic Area

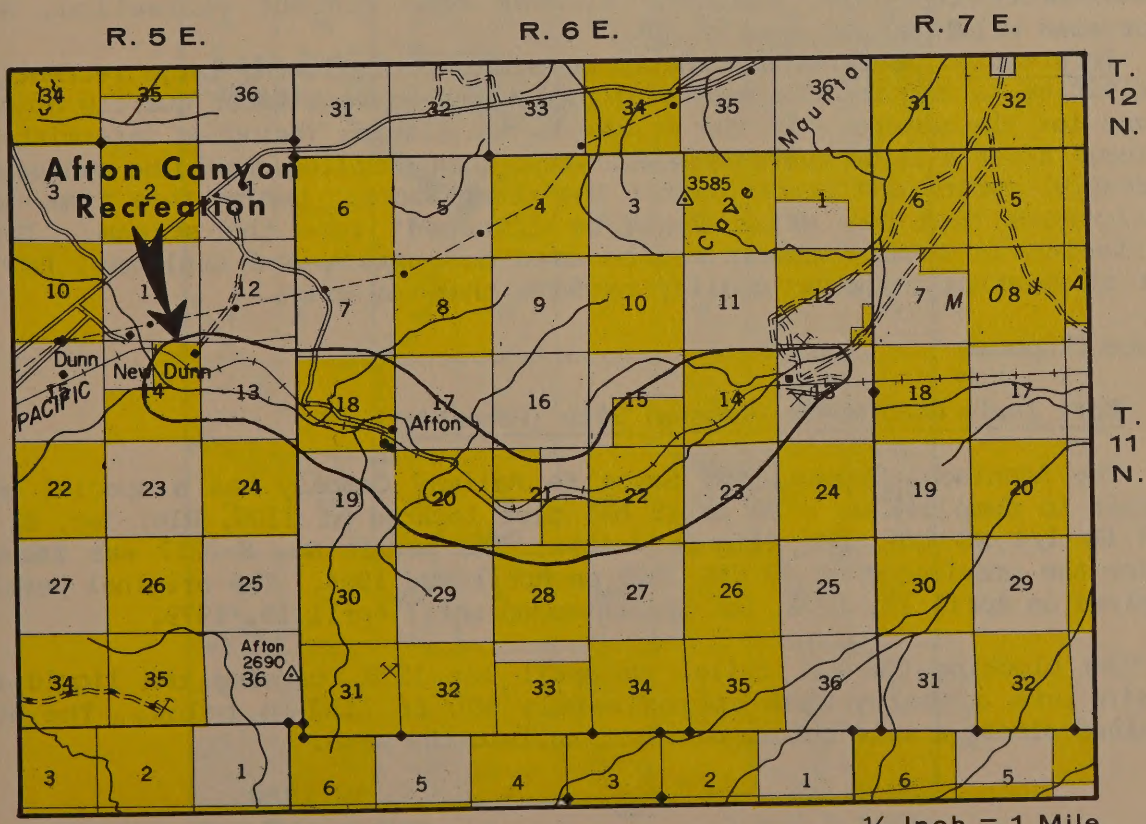


LEGEND

Potential Problem Area

Patented Lands

Public lands (BLM)



San Bernardino Base and Meridian

½ Inch = 1 Mile

Figure 3-39

ranching purposes. Ranching uses are also affected by the drying up of springs and seeps within areas formerly productive for livestock grazing. The redistribution of livestock to other sources of water results in a decrease of animal unit months (AUM's).

Information Needs: Overdraft of groundwater supplies in the Mojave Valley and the resultant lowering of the water table is already evident. Information is needed on the feasibility of alternative solutions to the problem. Potential solutions include, 1) regulation of water use, 2) re-evaluation of water rights and 3) importing surface water.

Recreation

Afton Canyon (Potential)

Afton Canyon (figure 3-39) located in T11N, R5E, SBM, is heavily used for camping and day use activity. Associated recreation includes ORV and equestrian usage. Occasionally, pre-planned events bring large numbers of horses and/or ORV's into the area with resulting impacts on the Mojave River. Impacts include nutrients, bacteria, and solid waste being received by the river.

Water flows through Afton Canyon ephemerally and empties into the Mojave River, an intermittent stream. Receiving water for the Mojave River is the Upper Mojave groundwater basin. The area is low mountainous with elevations ranging from 1500 ft (457 m) to 2500 ft (762 m) with typical desert surface of sparse vegetation and loosely consolidated soil.

Effect On Beneficial Uses: Beneficial uses of water from Afton Canyon are those of its receiving waters, the Mojave River. These are agricultural, groundwater recharge, recreation, warm and cold water fish habitat, and wildlife habitat. Effects on beneficial uses are poor quality water for groundwater recharge, possible disease from contact recreation, and decreased wildlife and aquatic life.

Information Needs: Data should be collected following large recreation activities to compare the resulting pollutants against water quality objectives for the waters. If the stream is not flowing (being an intermittent stream) after a large recreation activity, then sampling should be conducted (ideally) during and shortly after the first storm. During this time, any pollutants that may exist would be "flushed" into the stream. Data collected in such a manner can be used to justify and implement BMP's for alleviating any water quality concerns that may exist.

Waste Disposal

Fort Irwin Road Waste Disposal Site (Potential)

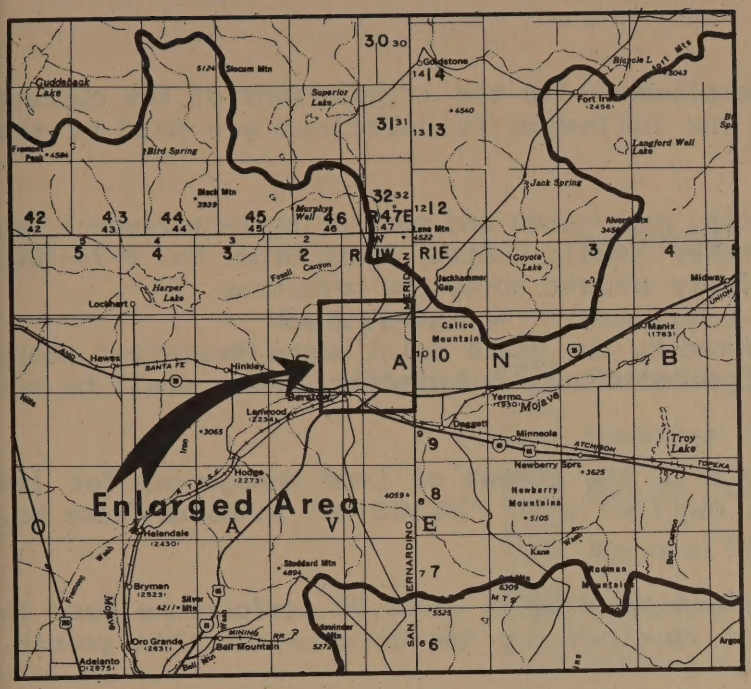
The Atchison, Topeka, and Santa Fe Railway Company has a special use permit to dump oil on a 20 ac (8 ha) plot located at T10N, R1W, Sec. 8, E 1/2 SW 1/4 NE 1/4, SBM (figure 3-40). The permit No. R-2217 was issued under the provisions of 43 CFR 2920 on April 20, 1964. The original permit expired on April 19, 1974, but was extended until April 19, 1979.

A dike blocking the oil failed on April 12, 1978, causing the liquid to drain into a nearby wash approximately 500 ft (152 m) below. The oil drained almost a mile before dissipating into the wash.

U.S. Bureau of Land Management
RIVERSIDE DISTRICT
WATER QUALITY PROBLEM ASSESSMENT

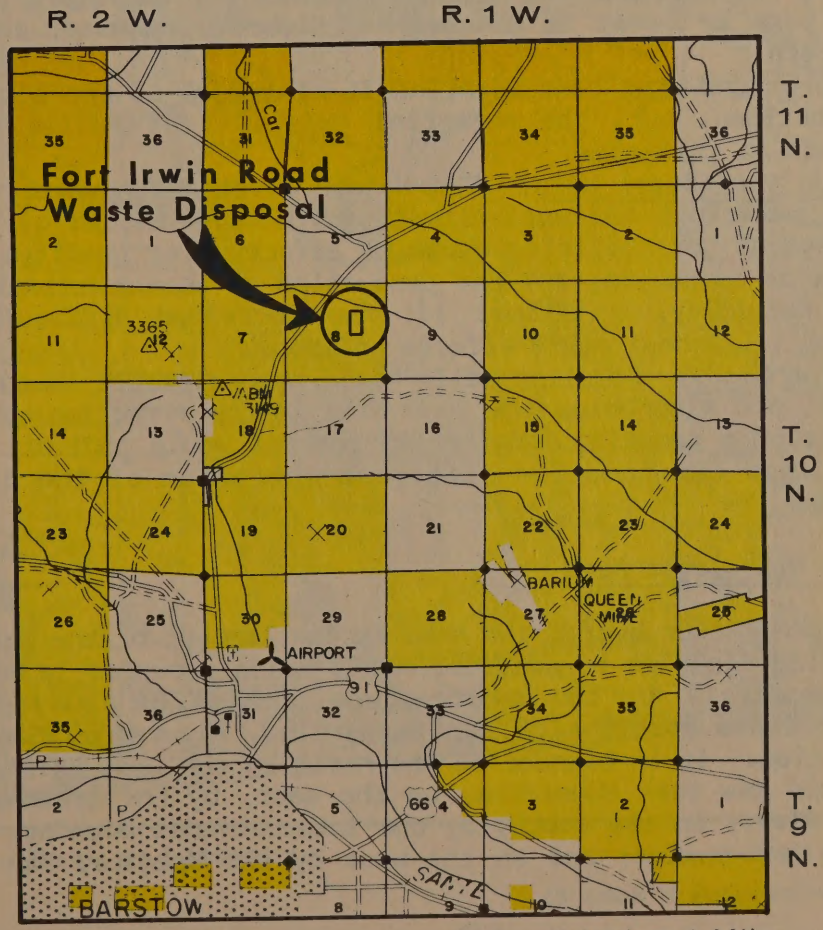
FORT IRWIN ROAD

Mojave Hydrologic Area



LEGEND

- Potential Problem Area
- Patented Lands
- Public Lands (BLM)



San Bernardino Base and Meridian

1 Inch = 1 Mile

Figure 3-40

It should be determined if compliance with the stipulations of the current permit is being attained. The following stipulations are part of the current permit:

(1) All discharge specifications, provisions and monitoring requirements set out in the Lahonton Regional Water Quality Control Board Order No. 6-74-106, adopted 9-26-74, shall be strictly adhered to by the permittee.

(2) Such standards as are adopted by the State Solid Waste Management Board for the enforcement of the approved County enforcement agency shall be met by the permittee.

(3) The permittee shall submit to the Bureau of Land Management for its approval a copy of the report required under "PROVISION" in Board Order No. 6-74-106.

(4) The permittee shall post and maintain a $1000.00 performance bond in favor of the United States of American for the duration of this permit.

(5) The permittee agrees that the Federal Government, Department of the Interior and the Bureau of Land Management and its representatives shall not be responsible for damage or injury to persons and property which may occur during the permitted use period or as a result of such use.

The railway company is presently dumping 12,000 gallons (45,425 l) of oil per day at the site and the potential exists for similiar future spills. Such spills pose a threat to the Mojave River groundwater basin and the receiving waters.

Threat to groundwater contamination is minimized at the site due to its operation practices, but, the potential exists. Oil spills are the most serious concern at this time.

Effects On Beneficial Uses: The Mojave River groundwater basin waters are used for municipal and agricultural purposes. Should oil contaminate the basin, several possibilities exist to affect water quality: (a) hazards to the health of consumers, (b) the production of wastes and odors, (c) the presence of turbidity, or films, (d) the increased difficulty of water treatment, and (e) undesireable effects on crops.

Information Needs: Sampling wells would be desireable immediately below the dump site, and also below the dump site in the direction of groundwater movement. Periodic sampling (quarterly) for oil would indicate any contamination and show the need for different operation of the dump, or for abatement.

West Colorado Hydrologic Area

The West Colorado River Hydrologic Area is the largest of the basins falling within Riverside District boundaries. This basin occupies 10 million acres (4 million hectares) in the southeastern portion of California (Figure 3-36), and includes portions of San Bernardino, Riverside, San Diego, and Imperial Counties. It is bounded on the north by the Ord, Bristol, Granite, Providence, and New York Mountains; on the east, by the drainage divide of the Colorado River; on the south, by the International Boundary between the United States and Mexico; and on the west by the Granite, San Bernardino,

U.S. Bureau of Land Management
RIVERSIDE DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

WEST COLORADO

LEGEND

Recreation — Suspected Problem Area

Mining — Potential Problem Area

Patented Lands

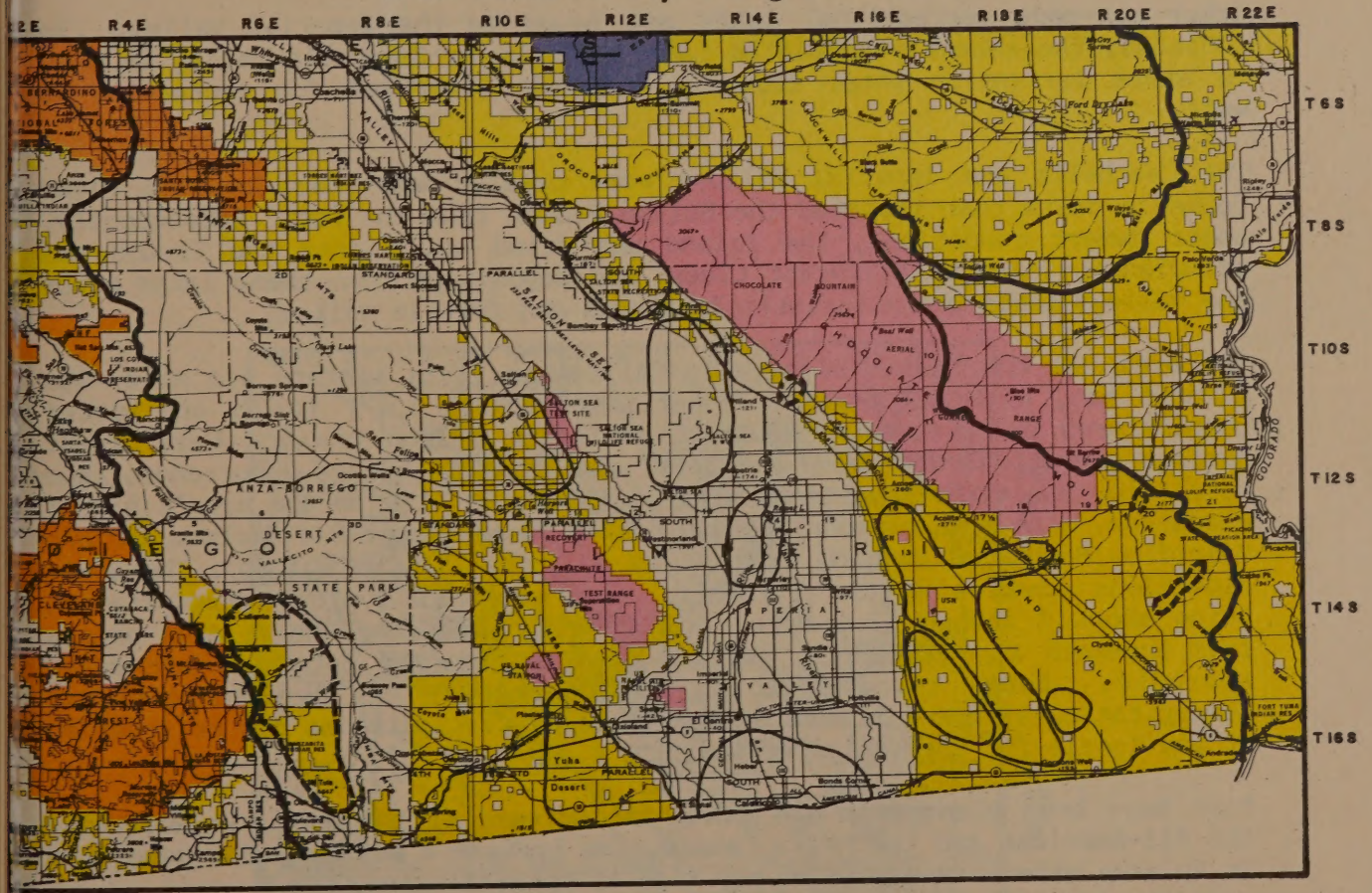
Public Lands (BLM)

National Forest Lands

National Park Lands

Military Lands

West Colorado Hydrologic Area



San Bernardino Base and Meridian

Scale 1 : 1,175,000
(1 Inch = Approximately 18½ Miles)

Figure 3-41

San Jacinto, and Laguna Mountains. The Basin is 200 miles (322 km) long from north to south and 75 miles (120 km) to 50 miles (80 km) wide from east to west. Its most geographically significant feature is the Salton Trough, which contains the Salton Sea and the Coachella and Imperial Valleys. The Trough is a structural extension of the Gulf of Lower California and in ancient times contained the huge Lake Cahuilla. Most of the economy and industry of the West Colorado River Basin is concentrated in this part of the area.

The northern half of the area drains to many individual internal sinks, or playas, while the southern half drains to the Salton Sea. Natural perennial streams are found only along the western boundary of the area in the San Bernardino and San Jacinto Mountains. All natural streams are diverted for water supply for local communities. Other perennial streams and canals are found in the Imperial and Coachella Valleys as a result of irrigation return flows.

The Salton Sea, located on the site of prehistoric lakes, was formed in 1905 by overflow of the Colorado River. Today, it serves as a drainage receptacle for irrigation return water which maintains the Sea and results in its being the largest and most important body of water in the area. Although the water is highly saline, due to the concentration of salt by evaporation, it is used extensively for boating and fishing.

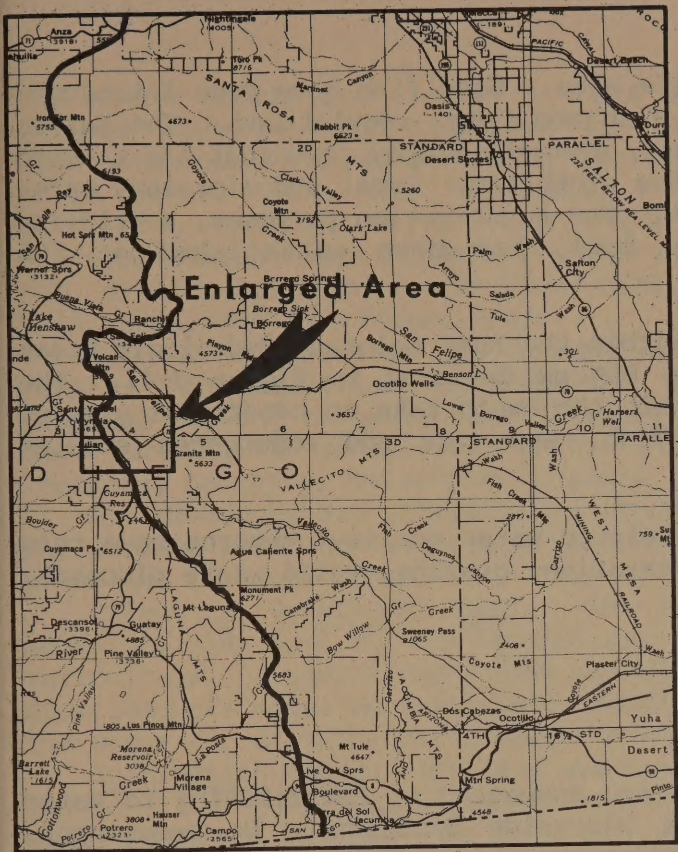
Other man-made recreational lakes are found in the Imperial Valley. In addition, the recently completed Lake Cahuilla in Coachella Valley is used to store irrigation water from the Colorado River and for recreation as well.

The Coachella and Imperial Valleys were created when the Colorado River formed a delta that isolated the Salton Trough from the Sea. Subsequently, under desert conditions, the inland sea dried up. Later the Trough was occupied by lakes at different times, and deposition into these lakes gives the valleys their characteristic flatlands and fertile soils.

The area has the driest climate in California. Its winters are mild, its summers hot, with temperatures sometimes reaching 120°F (49°C) and winter temperatures below zero. An exception is the Salton Trough, where ground surface elevations are below sea level and frost is a rare occurrence, thus permitting the growing of crops all year. Snow falls in the area's higher elevation, with mean seasonal precipitation in the upper San Jacinto and San Benardino Mountains ranging from 30 to 40 inches (76 to 101 cm). The lower elevations receive little rainfall, mean seasonal typical precipitation being about 3 inches (7.6 cm). Precipitation over the entire area occurs from November through April, but its distribution and intensity are often sporadic. Local thunder storms may contribute the average seasonal precipitation at one time, or only a trace of precipitation may be recorded at any locale for the entire season.

Fish have been planted in the perennial streams of the area. In addition, the All-American and Coachella Canals also provide a waterway for game fish in an area otherwise devoid of any kind of sport fishing.

West Colorado Hydrologic Area



U.S. Bureau of Land Management
RIVERSIDE DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

JULIAN DUMP

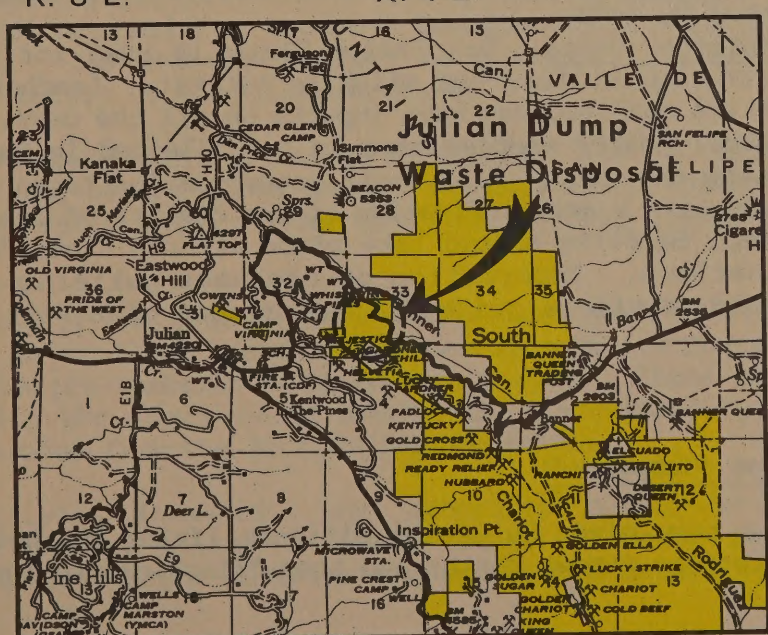
LEGEND

Suspected Problem Area

Patented Lands

Pubiic Lands (BLM)

R. 3 E.
R. 4 E.



T. 12 S.

T. 13 S.

San Bernardino Base
and Meridian

½ Inch = 1 Mile

Figure 3-42

The Salton Sea is a managed wildlife area. Game fish have been introduced and are taken under Department of Fish and Game regulations. The Salton Sea is famous for its Corvina fishery, a worthy trophy fish that has thrived since being transplanted from the Sea of Cortez. Local and migratory water birds are also attracted to the Sea. For conservation purposes, a wildlife refuge, primarily for migratory fowl, has been established at the southeastern end of the Sea.

A significant portion of the land within the West Colorado Hydrologic Areas is public land administered by the BLM as depicted in Figure 3-41. The waters on BLM administered land within the Basin take on beneficial uses of grazing, domestic, and wildlife, fish, and rare and endangered species habitat.

BLM management activities in which related water quality concerns have been identified are wildlife, mining, recreation, grazing, solid waste disposal, and geothermal production.

Waste Disposal

Julian Dump (Suspected)

Many solid waste disposal sites are suspected of contributing to water quality degradation throughout the Riverside District. No management, monitoring and construction stipulations were initially required for many of these dump sites. One such dump, Julian Dump, is cause for a lawsuit due to its pollutants entering Banner Canyon Creek.

Julian Dump is located in Banner Canyon within E 1/2, NE 1/4, Sec. 9, T.13S, R.4E. SBM (figure 3-42). Banner Creek, an intermittant stream, flows through the canyon during large, or prolonged small storms and drains into San Felipe Creek. All of the runoff eventually percolates into the groundwater basin, thereby contributing pollutants to it.

The Julian Dump is leased to the County of San Diego as a "public refuse disposal site." The lease (seial No. R-654) was issued on July 12, 1968 under the Recreation and Public Purposes Act (R&PP). The lease does not expire until November 2, 1992.

Effect On Beneficial Uses: San Felipe Creek is used for groundwater recharge, recreation, agriculture and wildlife habitat. Leachate from the dump, depending on its quality, can have impacts on all the uses.

Information Needs: Water samples need to be collected in Banner Canyon Creek above and below the dump. Also, soil water samples taken immediately below the dump would give a good indication of the quality of leachate being produced by the dump. Sampling should take place after a storm for the most accurate determinations. Information on drainage patterns around and below the dump would provide a guide for development of a best management practice.

Recreation

"Snowbird" Areas (Suspected)

"Snowbird" is a term given to senior citizens living in their homes in the northern U.S. for the summer months and then "flocking" to the desert in

the winter months and living in their self contained mobile homes. These people usually camp together for protection and security, thus, concentrations of campers result. The popular areas are: 1) McCain Valley which include T10S, R6E; T15S, R6E, T15S, R7E; T16S, R6E; T16S, R7E; and T17S, R7E, SBM, 2) Cavitan Wash within T13S, R21E, and T14S, R20E, SBM, 3) "Camp Dunlap" near Niland, 4) Black Mountain Area at T12S, R20E, SE 1/4, SBM, 5) Araz Junction Area at T16S, R21E, SE 1/4, SBM, 6) Midway Well within T11S, R20E, SBM (see figure 3-41).

Most of these sites are located along creeks, washes, springs, and canals. No facilities are available for sewage dumping and solid waste disposal leaving accumulations of solid wastes to have possible impacts on both surface and ground water. This possibility is due to percolation of leachate, bacteria, and direct disposal into washes.

All drainages are intermittent streams but, ephemeral springs do exist. All surface water not evaporated or consumed goes into groundwater recharge or to the Colorado River.

Effect on Beneficial Uses: The main beneficial use is groundwater recharge, but some of the waters are used for recreation, wildlife, and agriculture. Impacts can arise from bacteria and undesireable chemicals from leachate entering groundwater basins and surface waters. The value of the water for drinking and recreation will thereby be impaired.

Information Needs: Affected surface waters need to be tested for fecal coliform and fecal streptococci bacteria immediately after storms. Well water samples can be obtained and tested for chemicals that can be correlated with sewage and solid disposal areas. This data is necessary to determine if a water quality problem exists due to prolonged concentrations of campers.

East Colorado Hydrologic Area

The area lies in the extreme southeastern corner of the state (Figure 3-36). Its gross size is 3,600 square miles (9324 km^2). It is a narrow strip 200 miles (322 km) long with a maximum width of 70 miles (113 km). The eastern boundary generally follows the entire course of the Colorado River through California. The area's northern boundary is the California-Nevada stateline, and its southern boundary is the International Boundary with Mexico. Its western boundary is the drainage divide of the streams directly tributary to the Colorado River.

In general, desert peaks of around 4,000 feet (1219 m) high form the western boundary of the Basin. From these, the land slopes toward the river and is broken into valleys by stream channels cutting through the land to the river.

The mountains of the desert regions of southeastern California are composed largely of crystalline rocks, which are igneous, metamorphic, and volcanic types of the pre-Cambrian to Quarternary ages. These same types of rocks also underlie the ground-water basins and are covered by younger sediments that have eroded from the surrounding mountains.

These underlying formations are generally considered nonwater-bearing, although they may contain a small amount of water in fractures. The principal water-bearing material throughout the desert region is alluvium,

mainly that of the Quaternary period, although deep wells in some localities may yield water from beds of the upper Tertiary period. Surface area of the water-bearing sediments is 2,000 mi^2 (3219 km^2).

The climate of the Basin is charaterized by low annual precipitation, mild winters, and hot summers. The average annual rainfall rages from 3 in (7.62 cm) in the south to 8 in (20.3 cm) in the higher mountains at the north end. It falls mainly in the winter, although cloudbursts may occur in the summer.

Of the surface streams in the Basin, only the Colorado River flows year round. With a total drainage area of about 242,000 mi^2 (626,780 km^2) (in seven states), the river has had an unimpaired average annual flow of about 14 million af (1.7×10^{10} m^3) at Lee Ferry for the past 50 years. This value is considered to be the maximum dependable flow.

Surface runoff comes from the occasional rains, irrigation return flows, and waste discharges. An example of the surface flow is that in Arch Creek near Earp, which averaged 6.5 af(8018 m^3) for each of the 10 years ending in 1970, according to records of the USGS.

Water is diverted to the Colorado River aqueduct at Lake Havasu for export to the coastal counties of southern California. It is also diverted via the Palo Verde Canal near Blythe for irrigation in Palo Verde Valley.

The economy of the area is almost entirely oriented toward agriculture (irrigated), recreation, and tourism. Communities, all less than 10,000 in population, are scattered along the Colorado River. Both the urban areas and agriculture depend largely upon the river for their water supply. Small increases in both urban and agricultural water demands are forecast.

A number of resorts, which draw many recreationists for fishing and other water-related activities, have been built along the river. The number and size of these developments are expected to increase with the rising demand for leisure-time activities.

Recreation

Colorado River (Suspected)

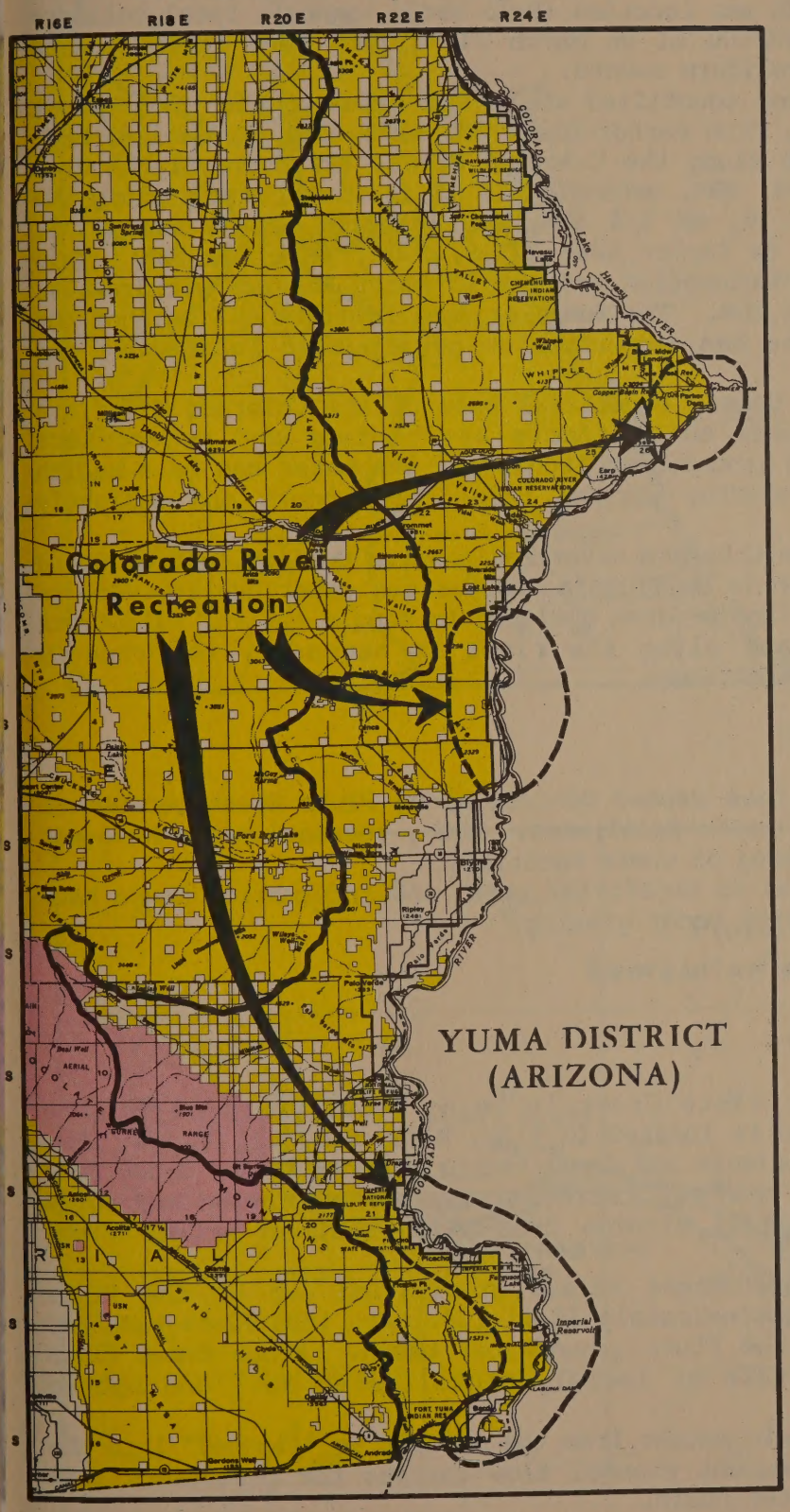
Public land at various locations along the Colorado River from Lake Havasu to the Mexican border is being used for undesignated recreation activity. Such activity involves day use, camping, boating, and swimming. The most serious impacts arise because of "gypsy camps" and large numbers of campers converging on favorite areas. Undesignated camping for a particular party lasts from one night up to several weeks, but, the "gypsy camp" parties stay for months (e.g. the winter season). Many other "camps" are comprised of permanent structures which have been in trespass for years.

Water quality concern from such activity comes about because of poor, or lack of sanitary measures. Few septic tanks, sewage disposal, and solid waste disposal facilities are available. Of the septic tanks in use, many of the associated leach fields are very close to the water table. Solid waste is not disposed of properly or managed in any suitable way, and

U.S. Bureau of Land Management
RIVERSIDE DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

COLORADO RIVER

East Colorado Hydrologic Area



LEGEND

- Suspected Problem Area
- BLM District Boundary
- Patented Lands
- Public Lands (BLM)
- Military Lands

San Bernardino Base and Meridian

Scale 1 : 1,175,000
(1 Inch = Approximately 18½ Miles)

Figure 3-43

leachate from disposal areas eventually enter the Colorado River.

The pollutants generated from the poor sanitary measures are fecal bacteria and nutrients. In one location (Palo Verde Lagoon), fecal coliform counts exceeded 24,000 MPN/100 ml on March 24, 1978. Many other locales have shown similiar high coliform counts.

Three regions have been identified where the situation is of greatest concern: (1) Parker Strip, from Parker Dam (T3N, R27E, Sec.34, SW 1/4, SBM) 11 1/2 mi (18.5 km) south along the Colorado River, (2) above Blythe from T2S, R23E, Sec. 14, NE 1/4, SBM, extending 14 mi (22.5 km) south along the river to T4S, R24E, Sec. 19, NE 1/4 SBM, and (3) from Raguna Dam (T15S, R23E, Sec. 24, SBM north to Taylor Lake (T12S, R22E, Sec. 23, SBM) This land is mostly Bureau of Reclamation and Public Water Reserve withdrawals, but is administered by the BLM. The Yuma, Arizona District Office, not the Riverside District Office has jurisdiction over public land along the Colorado River.

Effects On Beneficial Uses: Beneficial uses of the Colorado River are many. The beneficial uses this affects are contact and non-contact recreation, municipal, and groundwater recharge. The water can be a health hazard due to disease producing viruses. Also, fowl odors and unsightly scums result.

Information Needs: The Colorado River Basin Water Quality Control Board monitors the Colorado River in California and various water quality data is available. However, a sampling program designed to single out the pollutants generated from public land along the river is necessary to properly implement Best Management Practices.

Piute Creek (Suspected)

Day users and campers have caused concern along Piute Creek because of lacking sanitary and solid waste facilities. Also, recreationists have not been showing care in disposing of waste materials.

The description, effects on beneficial uses, and information needs have been described for Piute Creek under grazing.

Grazing

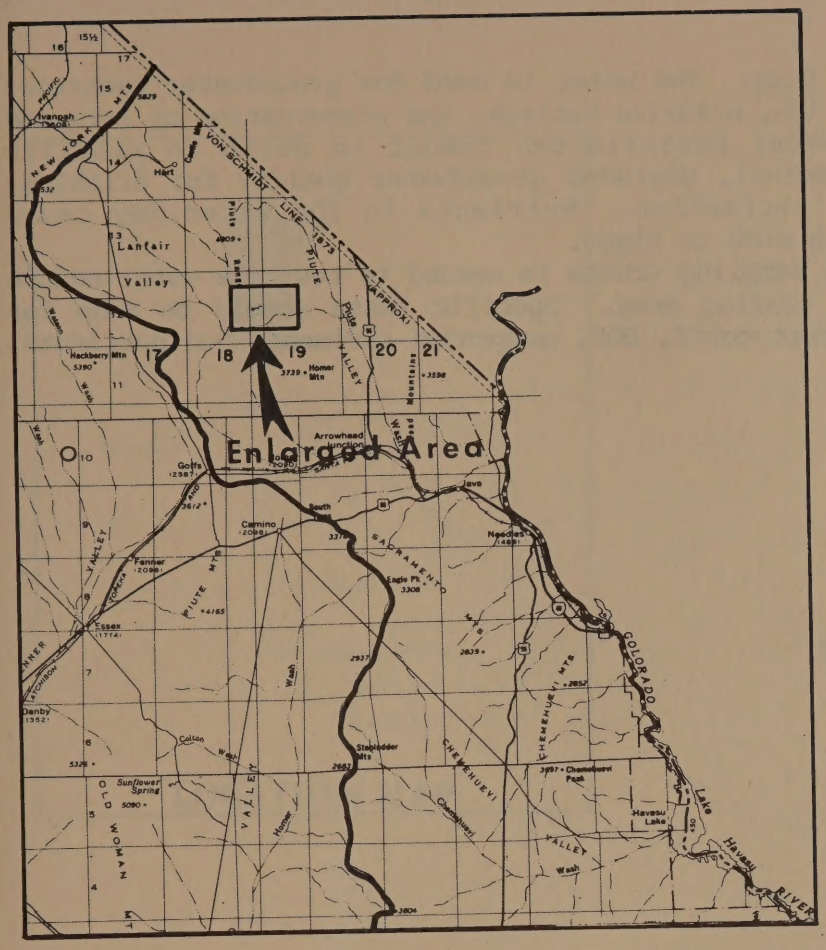
Piute Creek (Suspected)

Rangeland adjacent to Piute Creek is being heavily grazed (figure 3-44). The area of concern is located in T12N, R18E, Sec. 13, SE 1/4, SBM. Detrimental effects are nutrients and fecal bacteria entering the creek from animals in and nearby the channel. Also, streamside vegetation and soils are trampled resulting in rill erosion from which sediment enters Piute Creek.

Piute Creek is an intermittent stream originating out of the Piute Range. It flows easterly approximately 15 mi (24.1 km) into Piute Wash and is eventually received by the Piute groundwater basin. Piute Creek flows from steep to gentle terrain of loosely consolidated soil and sparse vegetation.

Disturbed soil and organic matter from the animals is "flushed" into the creek during storms. Subsequent channel flow carries the pollutants into the Piute Wash and groundwater basin.

East Colorado Hydrologic Area



U.S. Bureau of Land Management
RIVERSIDE DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

PIUTE CREEK

LEGEND

- Suspected Problem Area
- Patented Lands
- Public Lands (BLM)

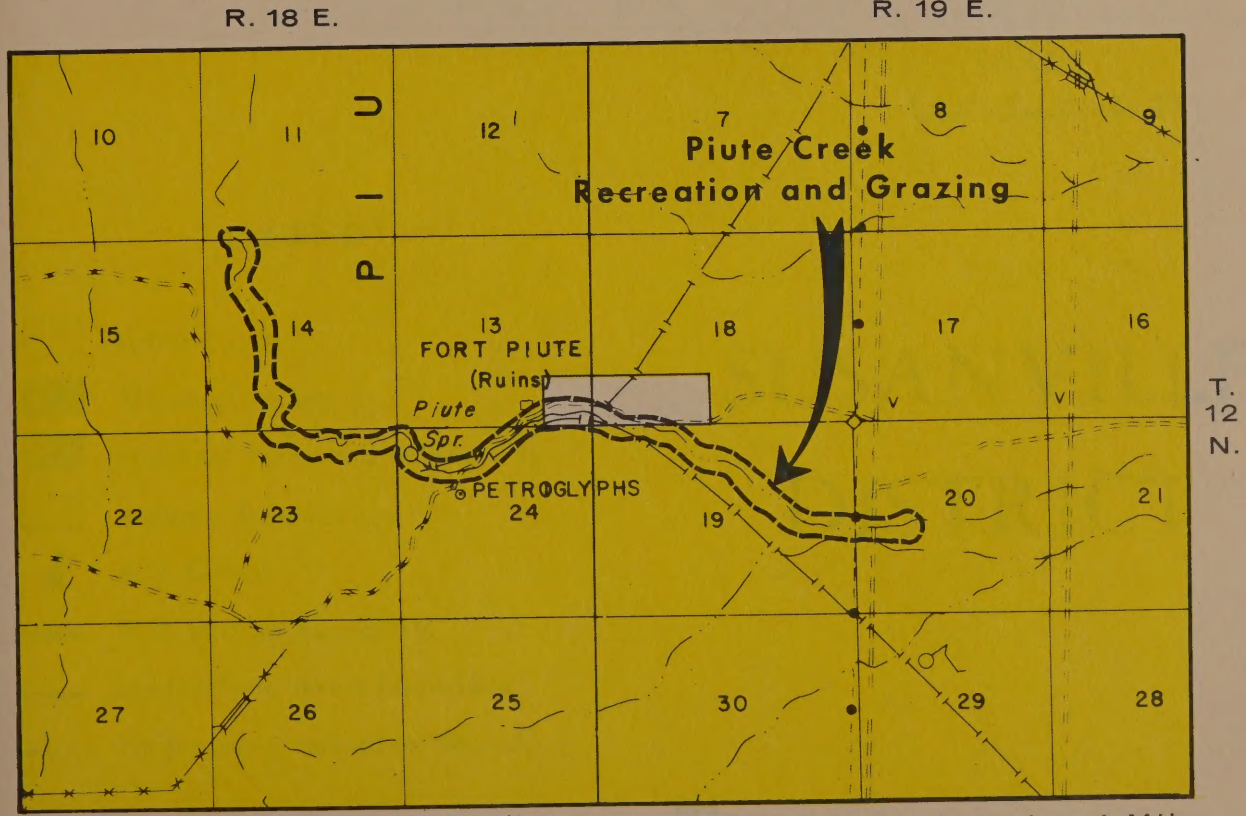
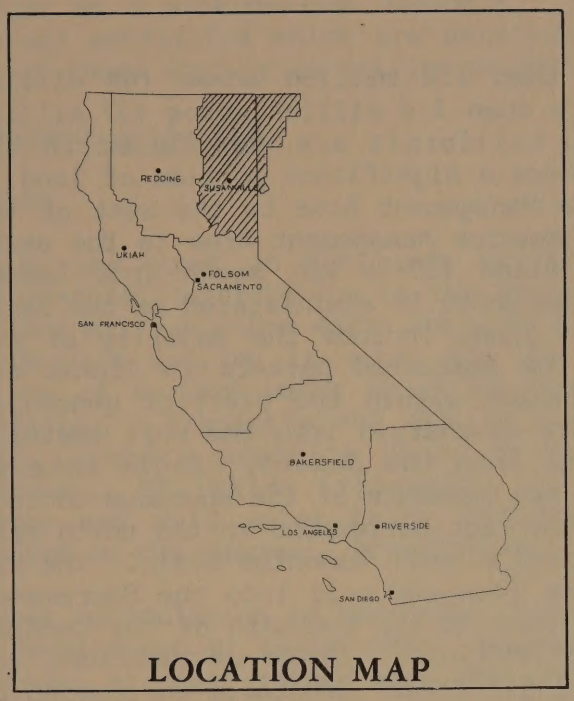


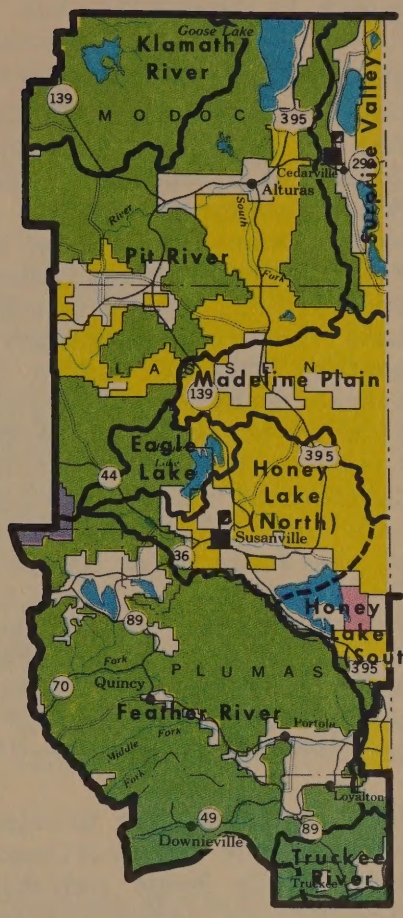
Figure 3-44

Effect On Beneficial Uses: The water is used for groundwater recharge, municipal supply, recreation, wildlife habitat, and preservation of rare and endangered species. Fecal bacteria can result in death to wildlife (including endangered species), degraded groundwater quality for drinking, and degraded water for recreation. Nutrients in the water may cause unfavorable aquatic growth such as algae.

Information Needs: A sampling scheme is needed to test the water before and after it passes the grazing area. Specific tests should be made for fecal coliform, fecal streptococci, BOD, suspended sediment, and nutrients.



LOCATION MAP



SCALE

0 5 10 20 30 40 50 Miles

LEGEND

- Public Lands
- National Forests
- National Parks and Monuments
- Military Reservations
- BLM Office
- BLM District Boundary
- Hydrologic Area Boundary
- Hydrologic Sub-area Boundary

SUSANVILLE DISTRICT

Figure 3-45

SUSANVILLE DISTRICT

The Susanville District manages more than 1.2 million acres (49 million ha) in northeastern California and more than 1.4 million acres (57 million ha) in Nevada. Only those lands in California are considered in the following discussion. The BLM administers a significant portion of land in Modoc County as the Pit River Resource Management Area to the west of the Warner Mountains and as the Surprise Resource Management Area to the east. Both Resource Areas extend 18 to 24 miles (29-39 km) south into Lassen County. All of the remaining land to the south is administered as the Eagle Lake Resource Management Area. These lands include the majority of the eastern half of Lassen County and a few scattered parcels in Plumas and Sierra Counties (Figure 3-1). The streams within the district generally flow to the east where their waters are discharged into the most westerly lakes of the Great Basin or disappear into the desert. Eagle Lake in California, as well as lakes in Nevada are remnants of the enormous ancient Lake Lahontan. These portions of the district correspond to the north half of the State Water Resources Control Board's North Lahontan Basin. The Pit River and Feather River drainage systems flow westerly into the Sacramento Valley and are within the Sacramento River Valley Subbasin of the Central Valley Region of the State's Basin designations. These designations are shown in figure 3-45 While the "Hydrologic Areas" generally correspond to the State's designation, they better reflect the hydrology and management strategy of the district.

Four physiographic provinces occur within the district. The Great Basin occupies the most northeasterly part of the district with the Modoc Plateau and Cascade Range radiating to the southwest. Diamond Mountain, south of Susanville, marks the northern limit of the Sierra Nevada Range where the Susanville District administers only an insignificant amount of land where no problems have been identified.

The block-faulting characteristic of the region, along with recent volcanic activity, have left most of the BLM administered lands in a relatively uneroded state. Stream channels and valleys are in early stages of development except where erosional forces have had the opportunity to modify the landscape where the erodible tuffs and agglomerates are exposed at the surface. However, the more recent basalt flows cover the softer material throughout much of the area. The high permeability characteristic of the surface rock of the basaltic terrains results in a nearly complete lack of surface drainage. Where streams do occur, the channels characteristically have steep-sided canyons and irregular gradients. The major valleys are structural troughs or grabens which have filled with sediments and for the most part, have no drainage outlet. Such basins are associated with the larger groundwater aquifers in the region.

The major lakes of the Great Basin and Modoc Plateau are remnents of a series of deep lakes formed during the Pleistocene epoch, when higher rainfalls and cooler weather prevailed. Drying of the lakes has occurred since that period resulting in the concentration of salts. Today the lakes are highly alkaline and of limited use.

Generally, surface water which exists on lands administered by the BLM is

managed as a multiple-use resource. The following describes some of the uses and activities which are associated with the waters in the district. Most of these activities utilize as well as effect surface waters.

Management Activities

Grazing

Grazing use occur on BLM lands in Lassen and Modoc counties and provides a substantial contribution to the economy of the area. Throughout the more than one million acres which are used for grazing within the district, water of adequate quality is vital for the sustenance of the range livestock. One use of surface water which is associated with livestock production is irrigation. Presently the BLM is not irrigating public lands, although local ranchers practice flood irrigation and wild flooding of their pastures. Sprinkler irrigation is increasing in popularity with both surface and well water being utilized. This practice provides various benefits to the rancher, depending on the circumstances.

Another manipulation of water for the benefit of livestock and wildlife is the development of reservoirs. Reservoirs are generally not located along perennial streams; rather they are used to provide water when intermittent streams would normally be dry. Reservoirs are regularly designed with wildlife and waterfoul benefits incorporated. In some cases, erosion control dams provide livestock and wildlife benefits.

Fish and Wildlife Habitat

Streams which flow throughout the year are also important to the maintenance of existing and potential sport fisheries. Virtually every perennial stream in the district has the potential for high quality habitat. Historically, grazing activities has led to conflicts with the maintenance of high quality cold water fisheries habitats. As these conflicts become evident special plans have been developed and monies provided so that range livestock and aquatic habitats could be managed mutually with a minimum conflict for the use of the water.

Wildlife and wild horse populations are also supported by perennial water supplies. Associated impacts from wild ungulate use results in conflicts with other aquatic habitats similar to those associated with livestock. At some locations these impacts have been recorded as being more severe. Beaver populations have altered the riparian vegetation and flow characteristics of many of the streams on the district, at times with adverse results.

Four wildlife refuges have been established in Modoc and Lassen Counties to accommodate migrating waterfoul along the Pacific Flyway. The stream systems of the region also provide suitable sites for migratory and non-migratory foul, as well as other sensitive habitats.

Silviculture

Every Hydrologic Area within the Susanville district has commercial

stands of timber. Most of these stands will require some sort of silvicultural treatment in order to meet the desired multiple use objectives of the BLM. It has been demonstrated that, in most instances, properly applied silvicultural manipulation of timber stands will not significantly affect water quality. In the Susanville District, there are no water quality problems known to exist which are a result of silvicultural activities. But the fact that the potential exists for impacts to occur through improper practices cannot be overlooked.

The major problems which are to guarded against, include sediment and organic intrusion into water bodies, and thermal loading of water bodies by removal of a shade producing canopy.

Logging roads are not considered part of the silvicultural activity and are discussed under the "Low Volume Roads" heading in Chapter Two. Logging roads were not considered to be the source of any water quality problems in the district.

Recreation

Modoc and Lassen counties also have a substantial trade which is related to tourism and recreation. Traditionally, many leisure time activities by travelers from outside the area are sustained by high quality water. With the continued increase in urban population coupled with increases in mobility, leisure time and environmental consciousness, there has been increased recreational enjoyment of the streams and lakes within the district. Unfortunately, this has lead to increased pressures on the stability of the aquatic and hydrologic systems. As a result any degradation of these systems results in reduced enjoyment of recreational and other beneficial uses.

A similar use of the waters within the Susanville District is enjoyed by local residents. Most have resided in the area for many years, and many for their entire life. The streams, lakes, and other water associated habitats are not only used by the people, but are an intrinsic part of their everyday life. These people have grown to accept some impacts which are associated with the activities which support their life style and are intolerant of those activities which are in conflict. The diversity and subtlety of these uses by the residents, while somewhat ambiguous, must be considered as a major beneficial use of the water if Public Lands are to be managed to the optimum benefit of public users.

The BLM is also cognizant of the need to maintain the quality and quantity of the groundwater. In the Susanville District some wells and springs are utilized for a visitor drinking water supply or for livestock. These withdrawals are minor compared to other withdrawals in the region. While problems with the chemical quality of some sources of groundwater have been identified elsewhere in the region, none are known to affect any beneficial uses of groundwater on BLM administered lands.

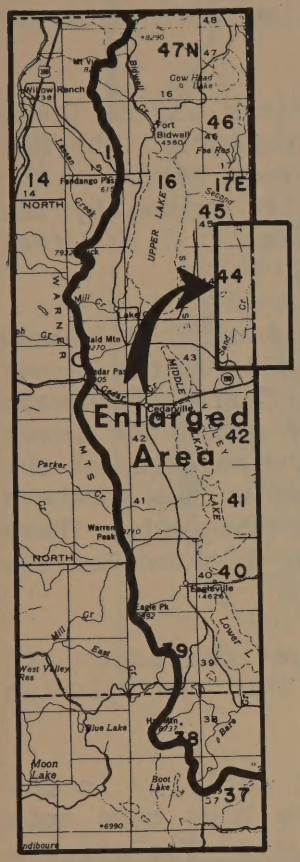
Surprise Valley Hydrologic Area

The Surprise Valley Hydrologic Area is generally identified by those

U.S. Bureau of Land Management
SUSANVILLE DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

SAND CREEK

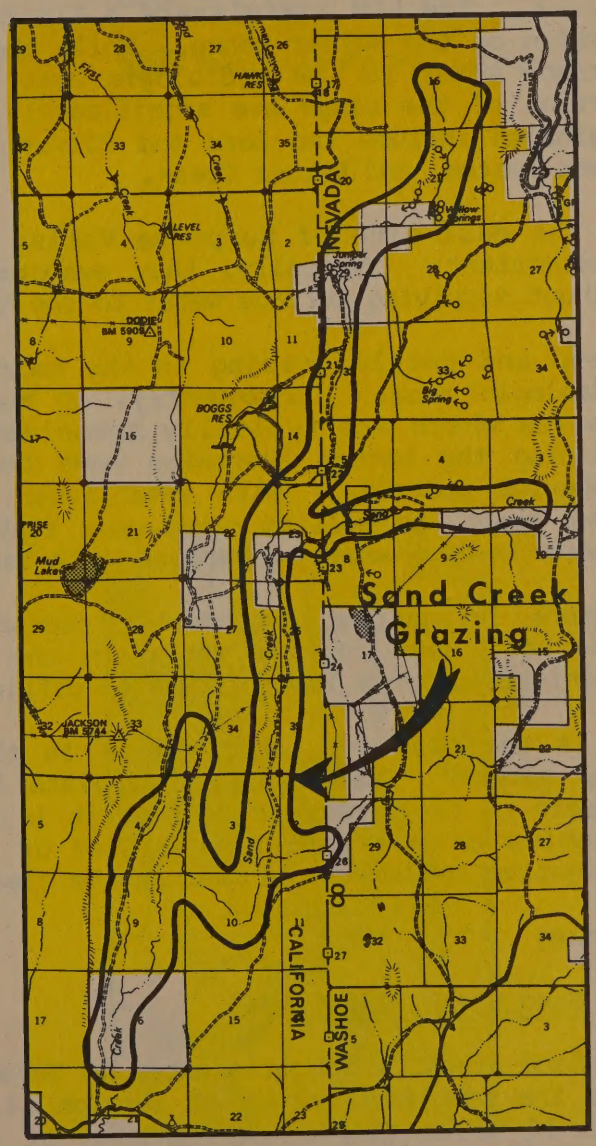
pse Valley Hydrologic Area



LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)

R. 17 E. R. 18 E.



T. 45 N.
T. 44 N.
T. 43 N.

½ Inch = 1 Mile

Mt. Diablo Base and Meridian

Figure 3-46

drainages which flow toward the Alkali Lakes. The area is mostly in Modoc county, but a portion extends into norheastern Lassen County. It lies east of the crest of the Warner Mountain Range and extends for about 15 miles (24 km) to the Nevada State Line. From the Oregon State Line the hydrologic area extends south for about 73 miles (117 km).

The hydrologic area is situated along the northwest fringe of the Great Basin section of the Basin and Range Physiographic Province. The BLM administers only a limited amount of land along the Warner Range. The Warner Range horst is separated from the Surprise Valley graben by the Surprise Valley Fault. The total displacement may be as much as 11,000 feet (3352 m).

Orographic condensation of moist air masses from the southwest causes precipitation in excess of 32 inches (81 cm) to fall annually in the Warner Mountains and about 6 inches (15 cm) annually along the California-Nevada Border. The BLM administers a limited amount of land along the lower portion of the Warner Range. While the Warners supply the majority of the surface water to the hydrologic area only those streams in the southern portion of the range are significantly effected by BLM management. These drainages include the Bare and Silver Creek systems, the Cole and Emerson Creek system, and Barber Creek.

On the east side of Surprise Valley most of the larger drainages are intermittent. Typically, they evaporate or infiltrate into the alluvium without supplying surface water to the Alkali Lakes.

Sheep and cattle grazing is the major BLM management activity in the hydrologic area. Consequently, in some locations there have been some impacts which are typically associated with grazing use. The streams draining the Warner Mountains have been reported as having a very good fisheries potential; with established populations of rainbow and German brown trout, as well as other game fish. Other wildlife use other surface waters in the area to various extents, depending on the body of water.

Pasture irrigation, groundwater recharge and domestic supply are other benefical uses of the water in the area. Recreational use on BLM administered lands is minor due to difficult access.

As is the case for other waters in the District, water quality data is very sparce. Even though biologists have identified some indicators of impacts to the aquatic resources it is difficult to clearly understand the dynamics of the impacts involved or document the benefits of planned mitigative and avoidance measures be clearly documented.

Grazing

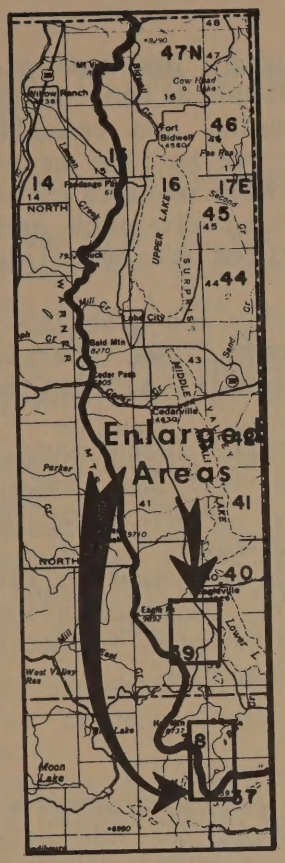
Sand Creek (Existing)

Sand Creek, which originates in Nevada, enters California in T44N, R17E near the southeast corner of Section 14. It then flows southerly for more than 10 miles (16 km) where most of its water enters the ground. An insignificant channel connects with Middle Alkali Lake. Almost the entire upper seven miles of channel is within California BLM jurisdiction.

Surprise Valley Hydrologic Area

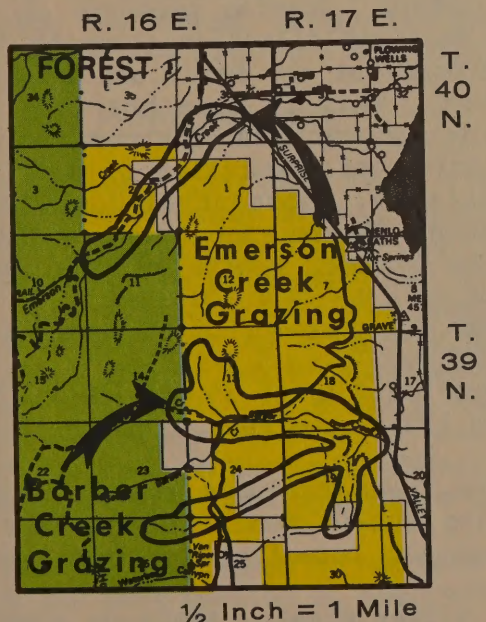
U.S. Bureau of Land Management
SUSANVILLE DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

EMERSON CREEK & BARE CREEK

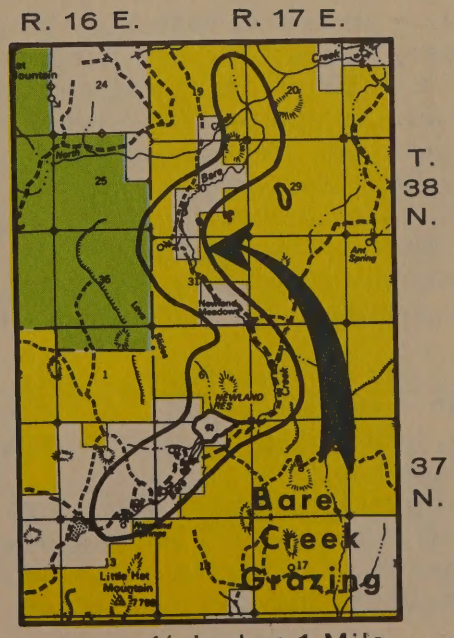


LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands



½ Inch = 1 Mile



½ Inch = 1 Mile

Mt. Diablo Base and Meridian

Figure 3-47

Based on observations of poor streambank conditions, low bank stability and channel stability, and high stream bed sedimentation, Sand Creek is considered to be severely degraded. Close grazing and trampling has reduced lower bank vegetation to a sod level. Active surface erosion and heavy bank sloughing has led to the accumulation of high amounts of sediment in the channel. Gravels have been obscured by organic muck and dense growths of aquatic vegetation. High stream temperatures are associated with these conditions.

Sand Creek is small and lacks a sufficient velocity and quantity of flow to keep gravels clean and aerated. Although the stream flows intermittently throughout most of its length in California, a perennial section meanders through a canyon valley in the northernmost portion.

Effect On Beneficial Uses: Sand Creek generally lacks many of the natural qualities of a trout stream. The section near the State border could be improved to be suitable for a fisheries. Other major benefits would include pasture irrigation and groundwater recharge.

Information Needs: More specific information on the existing fisheries in Sand Creek would provide a better understanding of the impacts involved. Monitoring of rehabilitative measures would also be helpful in determining the effectiveness of any programs which might be implemented.

Bare Creek (Existing)

Bare Creek gains its source of flow from the Newlands Reservoir, an 80 acre (32.4 ha) impoundment with storage capacity for 400 acre feet (493,400 m^3) of water. The reservoir is located in T37N, R17E, Sec. 7, MDM. The BLM administers lands along four miles (6.4 m) of the stream; the remaining land is in private ownership. The habitat condition of the 1 1/2 mile (2.4 km) stretch below the reservoir has been described as poor, and moderate below the 1 1/2 mile (2.4 km) point. Grazing pressure on the riparian habitat paralleling the stream's edge and siltation stemming from erosion has led to a reduction in the steepness of the banks and a wider, more shallow apprearance of the streambed. This in turn has led to a reduction in stream velocity, increase in the surface area of stream exposed to solar insolation, and has permitted significant quantities of silt and muck to collect in pools and on the substrate. Substantial downstream increases in temperature have been recorded. Thermograph readings taken in August and September, traditionally the hottest months of the year, showed water temperatures ranging from about 68°F to 74°F (20°C to 23 1/2°C), at a location 1 1/2 miles (2.4 km) downstream from the reservoir. Temperature increases ranged from 1°F to 10°F (1/2°C to 5 1/2°C).

Near the reservoir, discharge ranges from 5 (.2 m) to 15 cfs (.6 m). The stream averages ten feet (3 m) in width and 1/2 to two feet in depth in the area.

Effects On Beneficial Uses: The Bare Creek drainage system is the longest combined segment of stream crossing Public Lands in the Suprise Valley Hydrologic Area, and shows the greatest potential for cold water fisheries habitat.

Information Needs: The Bare Creek - Silver Creek - Newlands Aquatic Habitat Management Plan has recommended management guidelines for the improvement of riparian and aquatic habitats. Monitoring of water quality, stream bank and bed condition will be necessary in order to provide

information on the effectiveness of management practices and future requirements.

Emerson Creek (Existing)

Only one mile of the total eight mile stream length of Emerson Creek flows through BLM administered lands. These Public Lands are located in T39N, R16E, Sec. 1 and 2, MDM. Within this stretch, stream bank conditions indicate that grazing use may be causing an increase in sediment contribution to the stream. The steep banks with low density ground cover exhibit greater than 40 percent damage resulting in heavy surface erosional activity. However, the satisfactory condition of the bottom gravel and bottom fauna would tend to indicate that the stream is capable of maintaining acceptable water quality conditions for fish habitat under present management practices.

Emerson Creek flows at a rate of 10 cfs (.28 cms) down a steeply banked ravine. Aspen, willow, and waterbirch provide an estimated 75 percent shade canopy in the upper segment of the channel and 63 percent in the lower segments.

Barber Creek, the adjacent stream to the south, displays conditions similar to Emerson Creek but lacks sufficient flow to support productive fisheries.

Effects On Beneficial Uses: Cold water fisheries consisting of rainbow trout and German brown trout are reported in Emerson Creek. Plantings of trout occurred prior to 1965, but the present population, is unknown. Downstream uses would include groundwater recharge and irrigation in the Lower Alkali Lake area.

Information Needs: Before impacts can be assumed, sediment data would have to be collected to bracket the management activity suspected of effecting the stream. Fisheries information would also need to be collected to determine the fisheries potential which is being affected.

Eagle Lake Hydrologic Area

The Eagle Lake Hydrologic Area is defined by the crest of the ridges which confines the drainage of surface water towards Eagle Lake, forming a closed basin. The most prominant feature of the basin is the lake, which is considered to be of exceptional water quality and supports several unique aquatic organisms. The BLM administers the west portion of the Eagle Lake Planning Unit as a more or less contiguous block of land around the north-east end of Eagle Lake; including portions of Townships, 32 and 33N, R11 and 12E, MDM. This block includes lake frontage which extends from Miners Bay around the north end of the lake and down to Rocky Point. Presently, the BLM does not administer any land on the west side of the lake nor the portion of the hydrologic area west of Range 11.

The lake is maintained by surface and subsurface flows. Pine Creek which drains the west portion of the hydrologic area. outside BLM jurisdiction, is the major drainage supplying surface water to the lake. Merrill Creek and Papoose Creek supply considerably less surface water to the south end of the lake. Lands draining into these two streams are in private and public ownership with the U.S. Forest Service and BLM managing different portions of the Federal Lands.

The fractured volcanic rock associated with numerous faults provides the avenues for the subsurface supply of water into the lake. Underground water accounts for more than two thirds of the net inflow.

There are no natural surface outlets in the hydrologic area. However in 1875, Capt. C.A. Merrill provided for the construction of a 6000 foot (1829 m) tunnel to convey water from Eagle Lake to the head of Willow Creek and thence 18 miles (29 km) downstream to a point north of Honey Lake, by procurring the passage of the Desert Land Act. Mr. Merrill conceived the irrigation of 150,000 acres (60,705 ha) of dry sagebrush land and the development of the town of Belfast which would be the major community in the county. Due to financial problems the town and irrigated land never developed. Later the Bly Tunnel was constructed and functioned for a couple of years, until the lake level dropped and use for irrigation became unfeasible and the tunnel was plugged. A poorly plugged tunnel still remains.

The most notable feature of the lake is the famous Eagle Lake trout which is apparently a hybrid between the native Lahontan cutthroat trout and the introduced rainbow trout. The trout's notoriety is a result of its tolerance of the 8.4 to 9.6 pH, alkaline water in Eagle Lake and its rapid growth characteristic. Four other fish inhabit the lake including; tui chub, Tahoe sucker, Lahontan redsides, and speckled dace. The lake has also been credited as being the second largest fresh water lake completely within California; and besides Lake Tahoe, is the only natural lake in California that supports fishes of the ancient Lahontan system.

The east and north watersheds provide an opportunity for the BLM to manage Public Lands under their jurisdiction with recreation and aesthetics given primary consideration.

It is estimated that 90 percent of the county's day and overnight recreational activities center around Eagle Lake facilities. Presently the Gallatin Beach Campground which is administered by the U.S. Forest Service at the south end of the lake is the focal point of recreational activity; however, BLM administered lands with fewer facilities are receiving increased use. The recreational and aesthetic nature of the lake has led to increased recreational home and second home developments.

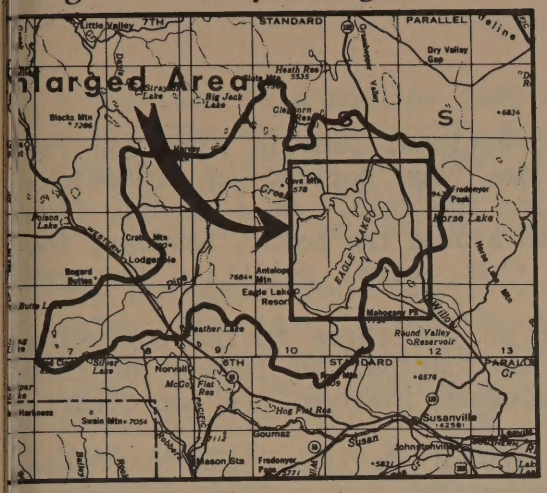
The BLM recognizes grazing and silvicultural activities conducted outside the major recreational areas as compatable with the objectives of maintaining the lake's character.

Grazing activities primarily consist of cattle use on a season long basis with a portion of the livestock water provided by reservoirs. Silvilcultural management is also present in the hydrologic area where a minor amount of selective cutting occurs. A document titled "Eagle Lake Master Plan" is in preparation, through interagency coordination.

Recreation

Rocky Point (Potential)

Rocky Point, located at the north end of Eagle Lake (T33N, R11E, Sec. 32



U.S. Bureau of Land Management
SUSANVILLE DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

EAGLE LAKE & ROCKY POINT

LEGEND

- Potential Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands

R. 10 E. R. 11 E. R. 12 E.

T. 33 N.

T. 32 N.

T. 31 N.

Rocky Point Recreation

Eagle Lake Domestic Sewage Pollution

Mt. Diablo Base and Meridian

½ Inch = 1 Mile

Figure 3-48

and 33, MDM), is frequently used as a recreational vehicle site and for fishing. Indiscriminate sewage disposal has been noticed on occassion. This practice has the potential for polluting the lake. As a result, five water sampling stations have been established around the point, however, the sampling data reviewed does not indicate that actual pollution has yet occured.

The south basin, which is the deepest of the three basins composing Eagle Lake, has indicators of premature eutrophication. The reason for this is thought to be natural, however, the processes involved are not clearly understood.

Although other BLM administered lands around the lake have not been observed to have the same problems, the potential for pollution through indiscriminate visitor use certainly exists.

Effects On Beneficial Uses: As described earlier, Eagle Lake is a lake of exceptional water quality, with unique fisheries. An increase of any pollutant will have a significant effect on the recreational and fisheries uses of the lake.

Information Needs: A reconnaissance of BLM administered lands around the lake should be conducted to establish levels of visitor use and the degree to which indiscriminate practices may have the potential for degrading the water quality of the lake. Continued intensive monitoring of the lake is absolutely necessary in order to better understand the processes which are involved in maintaining the unique features of this lake. Further, the continued monitoring will provide the information necessary for the early detection of any degradation of the lake's waters or acceleration of the eutrophication process, and the source of pollutants.

Sewage Pollution

Eagle Lake (Existing)

Water quality data of Eagle Lake indicates that the coliform levels have been increasing. The use of septic tank and leach field systems of sewage disposal has been cited as the cause of this increase. Increase in development around the lake would have the potential for increasing the volumes of both sewage and urban runoff reaching the lake.

Effects On Beneficial Uses: The actual effect of increased bacteria levels on the unique qualities of Eagle Lake is not clearly understood. Contact recreation and aquatic habitat are the major uses which could be affected, although no problems have been documented.

Information Needs: Continued monitoring of the lake is a necessary starting point to the understanding of lakes processes which are associated with micro-organic and bacterial activity.

Honey Lake Hydrologic Area

South of the Eagle Lake and Madeline Plains Hydrologic Area is the Honey Lake Hydrologic Area. The hydrologic area. includes the Susan River and Willow Creek watersheds which drain the watershed to the north of Honey Lake and supply surface and subsurface water to the lake. Horse Lake is also considered a part of the hydrologic area even though it seldom attains a level where overflow into Honey Lake occurs. Long Valley Creek drains the slopes to the south providing a substantial inflow into the lake.

Honey Lake is a shallow body of water about 100 square miles (259 km^2) in size. The water is highly alkaline and turbid, and during drought years is completely dry. The lake is important as a waterfowl habitat, although it supports no significant fisheries. The surface waters of the lake are too alkaline to use for irrigation.

The BLM administers small scattered blocks of land along the Susan River which originates in the vacinity of McCoy Flat Reservoir. In gerneral the river is used by wildlife, including a number of game birds and fish. The majority of land upstream from Susanville is covered with coniferous forest which provides the setting for a number of contact and non-contact uses. Most recently, the abandoned Southern Pacific railroad right-of-way which extends about 30 miles (48 km) to Westwood is being developed as a recreation trail. No grazing occurs in this portion of the drainage. Timber is marginal and is managed commensurate with recreational and aesthetic values.

The middle portion of Willow Creek, betweeen Willow Creek Valley and its confluence with Balls Canyon Creek,is administered as a nearly contiguous block including the two tributaries, Petes Creek and Balls Canyon Creek. Grazing, timber management, and wildlife habitat management are considered the major uses of the Willow Creek drainage.

The southeast end of Honey Lake, which is referred to as The Island and Long Valley, constitute the remainder of the major water use areas in the hydrologic area. The BLM manages a more or less contiguous strip of land on the east side of Long Valley and dispersed blocks on the west side. The Island includes about 3,800 acres (1538 ha) of Natural Resource Land interspersed with about 13,700 acres (5544 ha) private land. The Island is an important waterfowl habitat area where the management of 201 AUMs of licensed cattle grazing does not seem to create a conflict. There is also a fair potential for geothermal development and an environmental analysis is being conducted to determine the possible impacts from such activities.

An additional 27,500 acres (11,129 ha) of land is managed by the BLM in the Long Valley drainage. Grazing of about 2202 AUMs is the primary economic activity and apparently is not conflicting with other water uses. The area includes a critical deer winter range which is a major consideration in the management of the area. A herd of wild horses is also being maintained at a minimum size of 20 individuals. Other activities include four wheel drive and motorcycle use at locations throughout the valley. These activities have been identified as causing some accelerated surface erosion but due to the high infiltration rates of the associated soils, sediments are not being delivered to the stream channels. Mining has occurred in the past, however present and past activities are apparently not creating any conflicts or problems.

With the present levels of activities in the Honey Lake hydrologic area conflicts with the beneficial uses of the water do not seem to exist. However, since a potential for impacts by wildlife, wild horses and cattle exists, and since there is likely going to be increased recreational

pressure; Long Valley and the Susan River should be periodically reviewed to insure the present minimal level of impacts.

Grazing

Willow Creek (Existing)

Willow Creek, which flows southeasterly from its source in Section 26, T32N, R11E, MDM; enters Public Lands at the lower end of Willow Creek Valley. Public Lands continue for five miles beyond this point where grazing along the stream has trampled the banks and stripped the vegetation. In areas inaccessable to cattle, willows and sedges provide 10 percent to 40 percent shade cover and provide soil erosion protection. Increases in sediment, temperature, and coliform bacteria are suspected as a result of cattle use in the vicinity of the stream.

Willow Creek is a perennial stream which averages about 20,000 acre feet (24 1/2 million m^3) of discharge annually at the lower end of Willow Creek Valley. The area is covered with a basaltic crust and other porous volcanic formations resulting in a canyon where Willow Creek has cut through the lava plateau in the stream section above Belfast. The 50 to 150 foot (15 - 46 m) basaltic bluffs make Willow Creek inaccessable to cattle in those areas.

Effect On Beneficial Uses: Prior to entering Public Lands, the waters are used for flood irrigation in the Willow Creek Valley (see "Willow Creek" Diversion and Return Flows). Within the Public Lands, the Bureau of Land Management is mainly concerned with the fisheries potential of Willow Creek, as well as the livestock and wildlife uses of the water. Stream surveys by the Bureau of Land Management and California Department of Fish and Game have indicated that Willow Creek has a good potential for trout fisheries, but existing water quality conditions make it marginal for trout survival. German brown trout are exceptional in size but few in number. As a result Willow Creek has been cited as being potentially the best trophy brown trout stream in the state. Downstream from the Public Lands, Willow Creek and its tributaries are used as a water supply for irrigation, waterfowl and warm water fisheries habitat. Beyond the confluence with Susan River, Willow Creek waters contribute to aquatic habitats in the Dakin and Fleming Wildfoul Management Areas. The waters also contribute to the recharge of ground water north of Honey Lake.

Information Needs: While some water quality data is available it is insufficient to determine the effects of grazing impacts on fisheries habitat and downstream uses. A monitoring scheme to bracket the effects of current and future management activities should be considered for inclusion into the Habitat Management Plan which is proposed for 1979.

Recreation

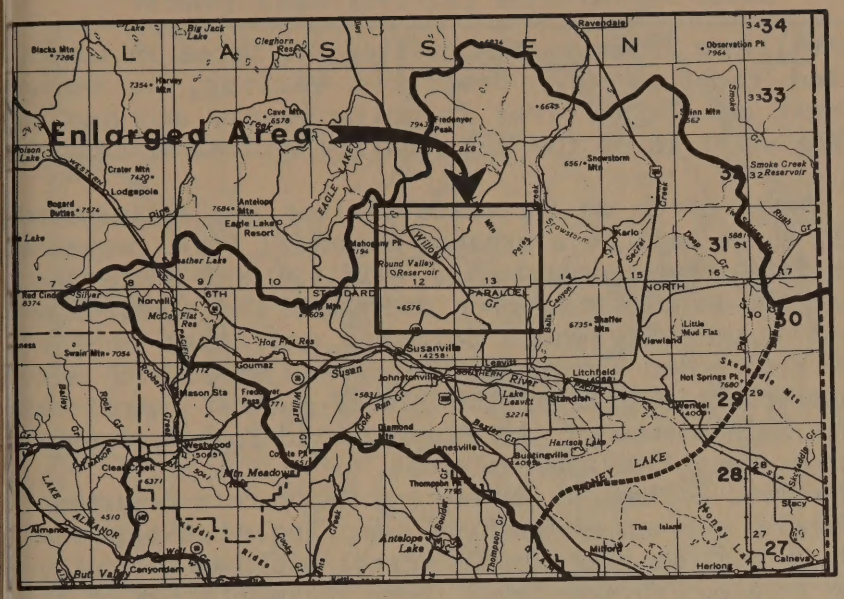
Susan River (Potential)

The Susan River is the most important stream in the Honey Lake Hydrologic Area. It originates from the McCoy Flat Reservoir in T30N, R9E, MDM and is supplied by ephemeral streams. Hog Flat Reservoir and several perennial springs also contribute to the constant flow in the upper drainage. The BLM administers several small blocks of land along the river

U.S. Bureau of Land Management
SUSANVILLE DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

WILLOW CREEK

Honey Lake (North) Hydrologic Area



LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)

Mt.Diablo Base and Meridian

½ Inch = 1 Mile

Figure 3-49

and its tributaries from Williams Creek to Susanville; 850 acres in total.

An abandoned railroad right-of-way, described earlier, is being developed for recreational use. The river is quite scenic and has an abundance of wildlife. The water is of the high quality typical of Cascade Mountain drainages.

Effect On Beneficial Uses: With an increased visitor use anticipated from a developing a trail, there will be a greater potential for a decrease in water quality. Aside from the recreational, wildlife and fisheries, grazing and other uses in the middle and upper drainage, the river flows through the community of Susanville where swimming and other contact activities occur. Several residences are along the river, some which were especially designed to appreciate a view of the river. Further downstream the river provides for the maintenance of the Fleming Wild Fowl Management Area as well as several other waterfowl habitat areas.

Information Needs: The U.S. Geological Survey and California Department of Water Resources maintain two water quality sampling stations near Susanville. In addition, a station near Devils Corral would be useful in monitoring impacts in the future. Ground level photo documentation of the entire length of the channel would also provide a permanent record of present conditions from which to assess changes.

Diversion and Return Flow

Willow Creek (Existing)

Willow Creek, which was described in the Grazing section, is almost entirely diverted from its main channel for flood irrigation of about 5,200 acres (2104 ha) of private lands in the Willow Creek Valley. The practice is reported to contribute greatly to the high temperature and turbidity observed where mixed return flows enter Public Lands. The diversion occurs four miles from Willow Creek's source springs near Eagle Lake and is carried in numerous ditches and channels for about 13 miles (21 km). Heavy growth of moss and aquatic vegetation build up in sluggish and dammed portions of the stream every summer.

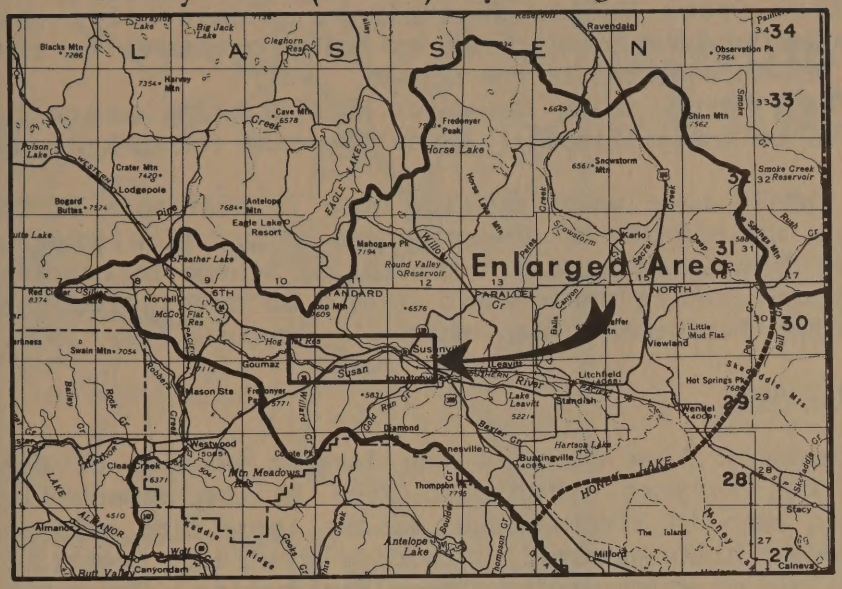
Willow Creek is perennial in the Willow Creek Valley; however, diversions occur only during the irrigation season. Runoff during the irrigation season amounts to about two-thirds of the annual runoff. Leachates, are the suspected cause of the high turbidities which impart a reddish-brown color to the waters entering Public Lands.

Effects On Beneficial Uses: Maximum daily water temperatures usually exceed 68°F (20°C) during the period of record from June through Sept., with a maximum recorded temperature of 71°F (26°C). However, these temperatures do not necessarily reflect the effect of the upstream irrigation practices nor their impacts on the beneficial uses described earlier. The only known reliable indication that impacts are affecting the fisheries resource on public lands is the documentation by the California Fish and Game memorandum of March 4, 1968 regarding the "Impact of Proposed Water Developments" on Willow Creek Fisheries. Citations were made that trout are unable to survive in the Willow Creek Valley, because of high temperatures or poor water quality or both. However, approximately one mile before entering the canyon, Willow Creek is recharged by permanent springs (Mapes Springs) having a constant temperature of 64°F (18°C) with a year-round discharge of 9 cfs (1.25 cms). Rainbow trout have been observed in the stream

U.S. Bureau of Land Management
SUSANVILLE DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

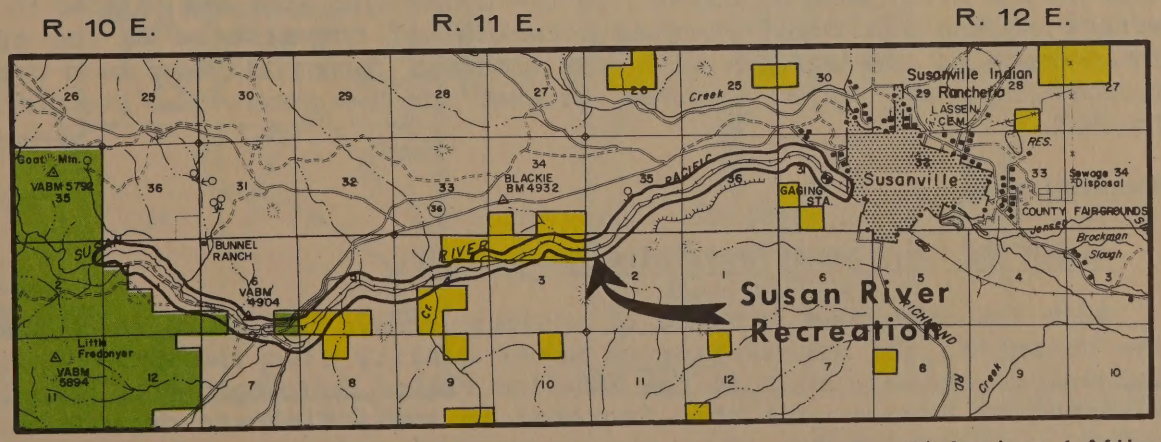
SUSAN RIVER

Honey Lake (North) Hydrologic Area



LEGEND

- Potential Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands



Mt. Diablo Base and Meridian

½ Inch = 1 Mile

Figure 3-50

segment above the Willow Creek Valley diversions. Conversely, the temperature and water quality have been cited as being conducive to the exceptional brown trout growth reported in the stream.

The effect on the range cattle using the water as a drinking source is unknown, but suspected to be insignificant. As is the case for downstream waterfowl habitat.

Information Needs: While some water quality data is available it is insufficient to determine the effects of diversion and return flow impacts on fisheries habitat and downstream uses. A monitoring scheme to bracket the effects of current and future management should be considered for inclusion into the Habitat Management Plan which is proposed for 1979.

Madeline Plains Hydrologic Area

The Madeline Plains Hydrologic Area contains the largest acreage of BLM administered land and the largest hydrologic area in the Susanville District. The hydrologic area is distinguished by the large flat area of Madeline Plains with adjacent hills generally providing about 1000 feet (305 m) of topographic relief, all of which drains into closed basins. There are no major lakes in the area, although several minor lakes are present. The 844 square mile (2186 km) hydrologic area is located to the south of the Surprise Valley and Pit River hydrologic area and to the north of the Eagle Lake and Honey Lake hydrologic area.

The BLM administers the majority of land within the hydrologic area. Grazing is the major management activity, with other uses being comparatively minor. The primary benefits derived from surface water in the hydrologic area are for aquatic and wildlife habitat, livestock watering, groundwater recharge, and a minor amount of recreation.

A number of reservoirs have been established as a water supply for livestock. Since many of these reservoirs support fish populations, a complimentary recreational activity is enjoyed. Migratory fowl also take advantage of these surface waters along the flyway.

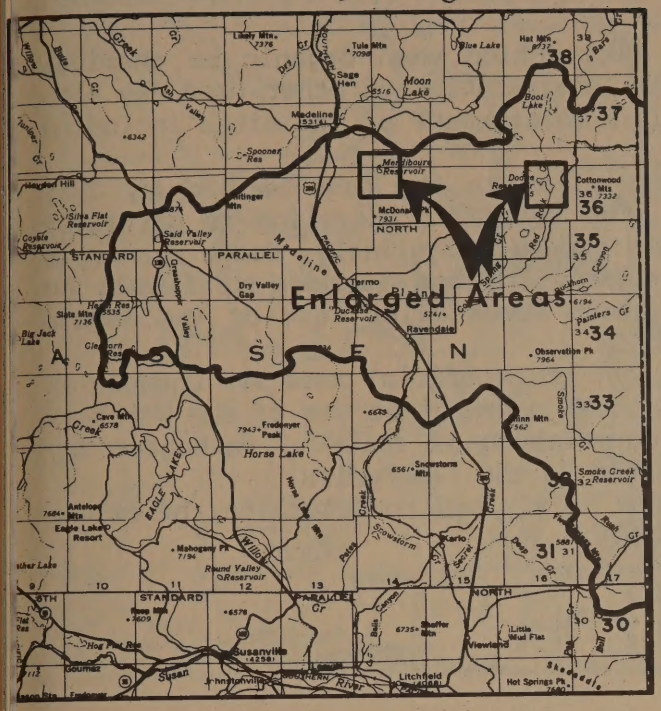
Most of the situations of concern in the hydrologic area are related to the effect on the limited fisheries potential of the streams in the area. Enhancement of the streams with the greatest potential have been incorporated into the normal planning process of the Susanville District of the BLM.

Recreation

Dodge and Mendibourn Reservoirs (Suspected)

With the continued increase of visitor use on BLM administered lands, the potential for degradation of water quality also increases. Dodge and Mendiboure Reservoirs in the Madeline Plains Hydrologic Area have been observed to have a noticable increase in indiscriminate deposition of refuse. Unfortunately, when one recreationist leaves refuse behind it usually has the greatest impact on the next users of the area. This impact on the aesthetic quality of a water associated use is impossible to

Madeline Plain Hydrologic Area

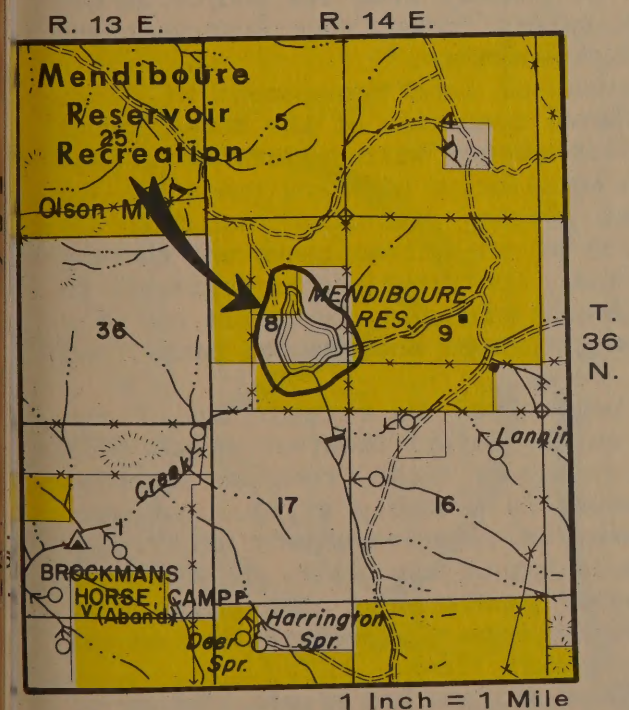


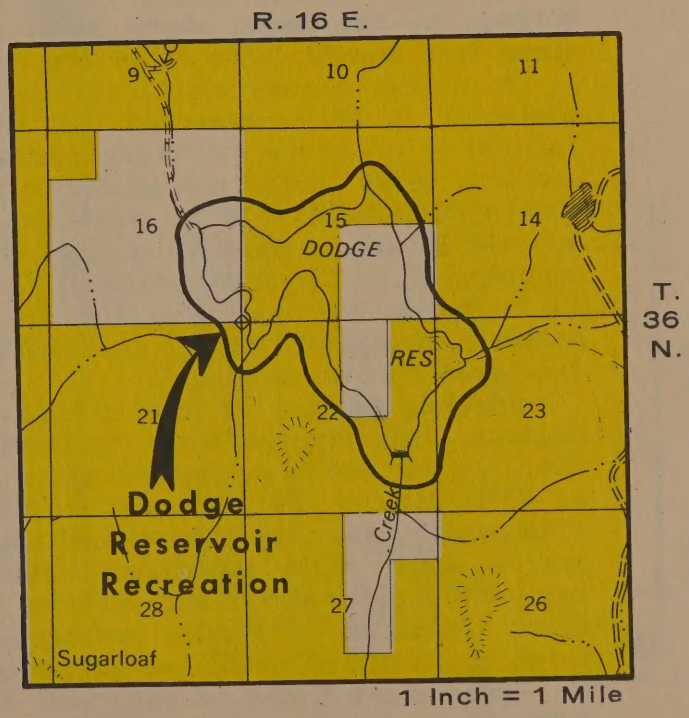
U.S. Bureau of Land Management
SUSANVILLE DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

MENDIBOURE RESERVOIR & DODGE RESERVOIR

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)





Diablo Base and Meridian

Figure 3-51

quantify. In addition to aesthetic degradation when organic or chemical refuse is deposited into a water course, degradation of other uses may also be realized. The BLM carrys out regular maintenance of the sites including refuse disposal.

Mendiboure Reservoir is about five miles to the east of Highway 395; located in T36N, R14E, Sec. 8, MDM. The reservoir shoreline is partially managed by BLM and partially by private owners. Similarly, Dodge reservoir is under joint public and private ownership; but is more difficult to access. Dodge reservoir is located about seven miles west of the Nevada border in T36N, R16E, Sec. 15,16, and 22.

Effect On Beneficial Uses: The effect on beneficial uses are unknown as is the extent of the problem. Recreational non-contact use of the water is apparently degraded as a result of accumulation of refuse. Pathogens may also result from organic garbage deposited in the reservoirs.

Information Needs: The areas should be visited to determine the extent that the water quality is being affected.

Grazing

Smoke Creek (Existing)

Smoke Creek drains the south slopes of Observation Mountain and the east slopes of Shinn Mountain, then flows generally to the southeast through T 33 and 32 N, R 16 and 17 E, MDM, respectively; then into Nevada. Smoke Creek drainage is primarily used for the grazing of range cattle. This range use has lead to both existing and suspected impacts on other uses of the stream. Of the twelve lineal miles of channel from its source at Big Springs to the point where Smoke Creek enters Smoke Creek Reservoir and flows into Nevada, nine miles are in public ownership.

A stream survey conducted by a Bureau of Land Management Wildlife Biologist in 1977 documented that the general condition of the stream banks indicated moderate to heavy surface disturbance with moderate surface erosion. Bank conditions appear to be in equilibrium with environmental and grazing stresses. It is felt that past grazing practices including use by wild horses, have altered the condition of the stream banks and thereby contributed to the degradation of the stream. Contributions of sediments to the streambed may have been the result of bank sloughing by cattle and wild horses, overland transport by runoff from compacted and denuded banks, and increased streambank scour.

Thermal loading of the stream has been cited as a condition of the channel. Big Springs water temperature on the day of observation was 58°F (14.5°C) and the high diurnal water temperature of Smoke Creek was recorded at 77°F (25°C). The increase in temperature is probably a result of several conditions. The removal and suppression of riparian vegetation through grazing would allow for direct solar insolation of the creek; as would the removal of cottonwoods and willows by beaver populations. The practice of flood irrigation of meadow pasture would also have a warming affect on and tends to lower the dissolved oxygen of the return flows.

Upper Smoke Creek is perennial in nature and has had a past history of supporting rainbow trout. Wildlife biologists feel that stream conditions exhibit a good potential as a cold water fisheries with the lower three miles having the optimum habitat conditions.

U.S. Bureau of Land Management
SUSANVILLE DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

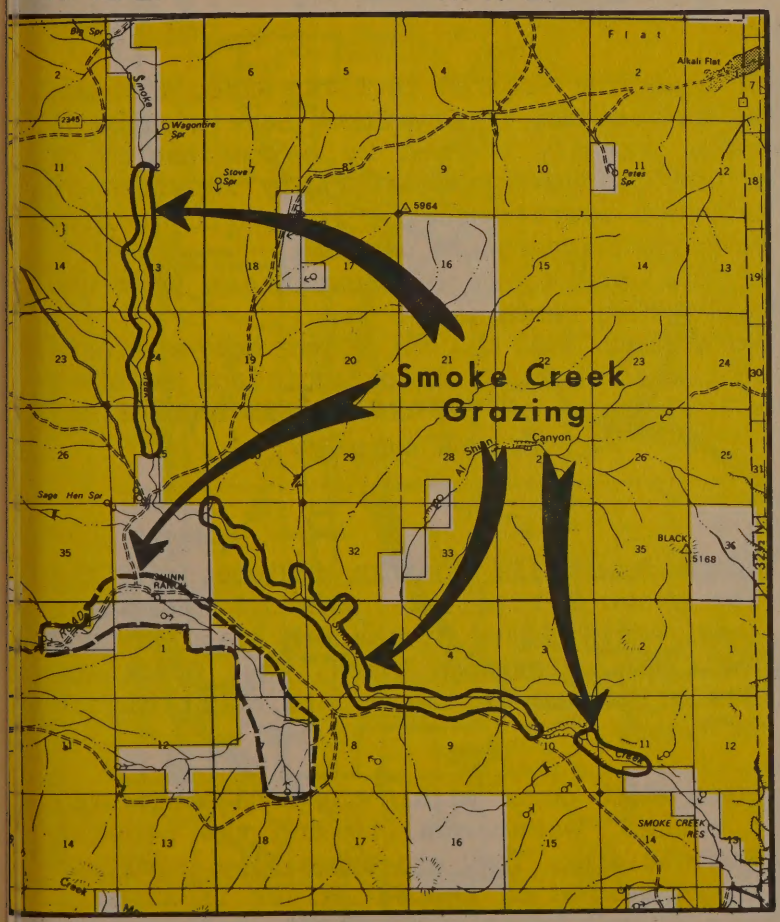
SMOKE CREEK & DRY CREEK

Madeline Plain Hydrologic Area

LEGEND

- Existing Problem Area
- Suspected Problem Area
- Patented Lands
- Public Lands (BLM)

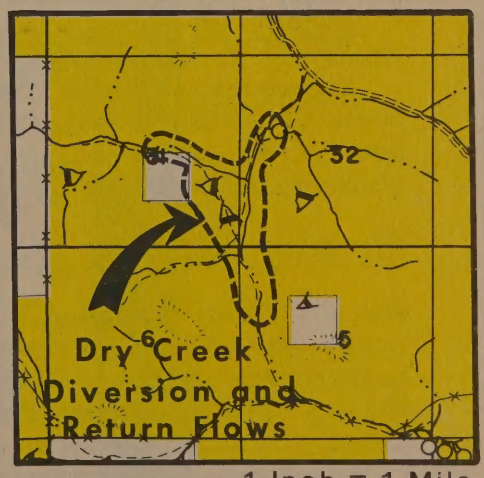
R. 16 E. R. 17 E.



T. 33 N.

T. 32 N.

R. 15 E.



T. 37 N.

T. 36 N.

1 Inch = 1 Mile

Mt. Diablo Base and Meridian ½ Inch = 1 Mile

Figure 3-52

Smoke Creek (Suspected)

As previously discussed in this section, Smoke Creek drains the southeast portion of the Madeline Hydrologic Area before flowing into Nevada.

Dead cattle have reportedly been left either in the channel or in areas subject to flood irrigation in those portions of lower Smoke Creek which are under private ownership in Nevada. This condition does not effect waters passing through Public Lands in California. However, the same condition is suspected to be occurring in the private lands in the vicinity of the Shinn Ranch. If this is the case, there would likely be an increase in the types and numbers of water borne pathogens and parasites.

Effects On Beneficial Uses: Currently the downstream waters under public ownership are used as a water supply for range cattle and as aquatic and wildlife habitats. The effect on these uses, if any, is unkown and would depend on the nature of pathogens and parasites involved. Smoke Creek is perennial downstream from the Shinn Ranch and is recharged by numerous springs. Therefore, the effect would likely be somewhat diluted with distance from the source.

Information Needs: Before actual water quality data would need to be collected, the suspicion that cattle are being left in the creek should be verified; followed by an inquiry with the landowner.

Diversion and Return Flow

Dry Creek (Suspected)

Downstream from an irrigation reservoir located in T37N, R15E, sec. 31, SE 1/4 MDM, the banks and bed of a tributary to Dry Creek have been badly scoured. The condition, which is probably created by a combination of reservoir releases and cattle use damage has undoubtably resulted in increases in the volume of sediment carried during intermittent flow periods. The actual volume of sediment discharge is unknown.

Effect On Beneficial Uses: The only known use downstream from the reservoir is irrigation by the Cold Spring Ranch.

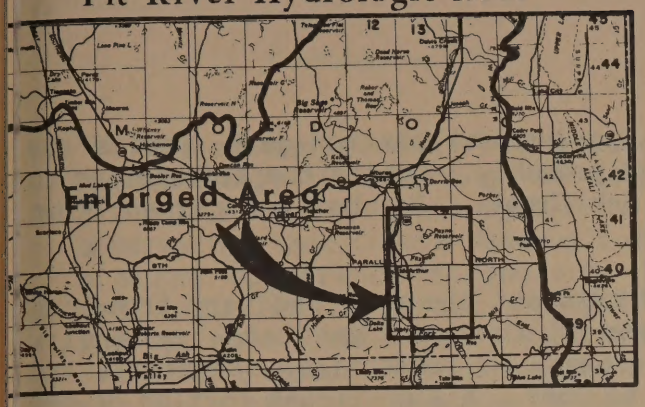
Information Needs: Annual work plans for the Pit River Resource Area schedule rehabilitory measures for the channel. Photographic and sediment monitoring is needed to provide information on the downstream impacts and recovery rate of the channel.

Pit River Hydrologic Area

The Pit River Hydrologic Area of the Susanville District includes only the upper Pit River drainage system above Pittville. Some of the major tributaries which flow through lands administered by the BLM are: Ash and Willow Creeks, Parker Creek, Pine Creek, Fitzpaugh Creek, East Creek and Cedar Creek. The stream courses originate in the mountains or higher plateaus and drain towards the Pit River.

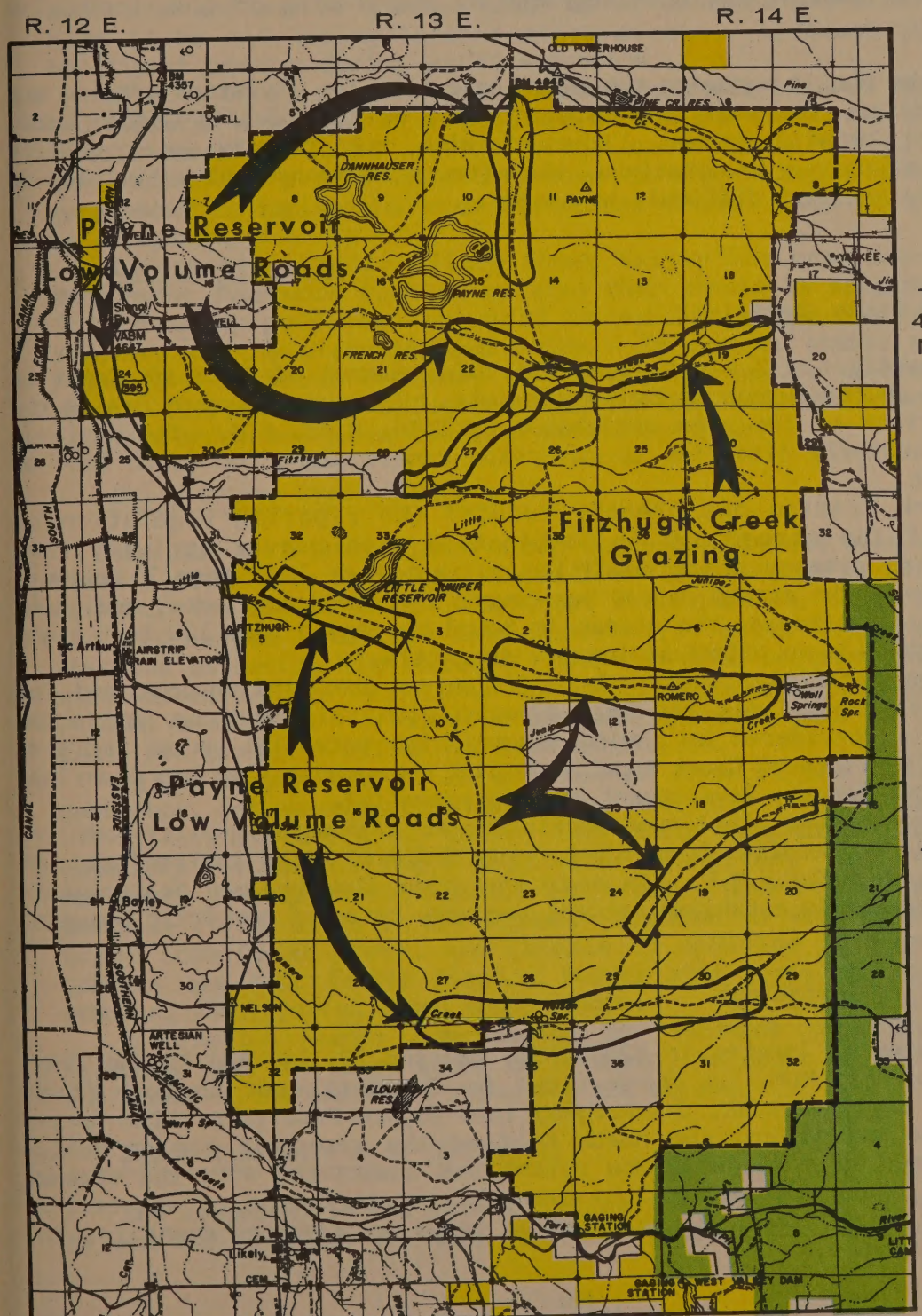
The perennial streams and reservoirs which occur within the management area enhance the beauty, aesthetic values, water quality and the general environment of the Pit River Hydrologic Area. They are especially important to livestock and wildlife. The fisheries of the Pit River is also of

Pit River Hydrologic Area



U.S. Bureau of Land Management
SUSANVILLE DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

PAYNE RESERVOIR & FITZHUGH CREEK



LEGEND

- Existing Problem Area
- Suspected Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands

Mt Diablo Base and Meridian

Figure 3-53

½ Inch = 1 Mile

significant importance. Seven game species and six non-game species are known to exist. The rare Modoc sucker probably inhabits the tributaries to the Pit River and is documented in Ash Creek. Rainbow and German brown trout are the most important game fish.

The aquatic resources are scattered throughout the area and vary from high mountain streams, which provide some of the best habitats, to a slow meandering river with intermittent streams and reservoirs. Generally the habitat quality ranges from excellent to poor. A significant portion of the stream aquatic habitat has been degraded by overgrazing or from irrigation diversions.

Currently, the BLM is managing the hydrologic area for livestock grazing and wildlife habitat, including the Emigrant Unit of the Devil's Garden Herd, approximating 20 wild horses. However, with only cursory water quality information at only a few stations, the effects of management activities on water quality are very difficult to assess.

Grazing

Fitzhugh Creek (Existing)

Approximately 6 1/2 miles along the main channel of Fitzhugh Creek is administered by the Bureau of Land Management. The stream system drains the southern portion of the area designated by T41N, R13E, MDM. The drainage flows in a westerly direction to diversion canals along the South Fork of the Pit River.

Livestock Grazing has greatly reduced the riparian vegetation on stretches of the stream and in combination with beaver activity, has resulted in an average shade condition estimated at less than 7 percent. Livestock use in the stream course has caused increased nutrients, sediment, and turbidity. Although, the stream is bound by canyon rims 100 feet high, they do not provide an effective barrier to cattle.

Effect On Beneficial Uses: In addition to use by livestock and for irrigation; Fitzhugh Creek has been planted with rainbow trout and brown trout. It is considered as having a very high potential as an improved fisheries. The Fitzhugh Creek Aquatic Habitat Management Plan has described recommendations for the development of this potential.

Information needs: Continued monitoring at four water quality sampling stations would be beneficial in identifying recovery rates realized through implementation of the H.M.P. In addition, high flow bedload measurements would be desirable to establish natural recovery rates of compacted spawning gravels.

Sheep Valley (Existing)

Sheep Valley is located in T35N, R9E, Section 10, 14, and 15 and T36N, R9E, Section 33, MDM. A creek flows to the northwest through Sheep Valley; then zig zags west, discharging into Coyote Reservoir. The entire length of the stream and the north half of the reservoir are on public lands. Apparently a large meadow system was associated with the stream; however, the lands adjacent to the channel are now devoid of vegetation. Over grazing in the past is suspected of being a causative agent for the present condition.

The stream channel has undergone severe cutting, creating a gully approximately 15 feet deep, 25 feet wide and 3/4 to a mile (4.5m X 7.5m X 1.2 km) in length. This indication of sediment displacement, along with the observation that Coyote Reservoir (two miles (3.2 km) downstream) exhibits a muddy appearance throughout the year, supports the suspicion that sedimentation is having a significant effect on downstream resources. Through quick calculation, something in the neighborhood of a million cubic feet (28 thousand m^3) of sediment has been delivered to Coyote Reservoir or is in transit storage in the stream channel. Transport of stored sediments and active erosion would be of greatest magnitude during spring high flows and during intense storm events. Although the effects may be of most concern during low flow periods.

Effects On Beneficial Uses: Coyote Reservoir is used for sport fishing and supports a population of cold and warm water fish. The primary function of the reservoir is to provide irrigation to Dixie Valley. Management of the stream for a cold water fisheries is also being considered. If such management is implemented some structural control measures will undoubtedly be necessary.

Information Needs: Since Sheep Valley has been identified in the Management Framework Plan as an area that should be excluded from grazing for recovery purposes, it would be worthwhile to monitor the rate of recovery of the streambed and banks. If channel stabilization is to be planned, a detailed inventory of the channel may be necesary in order to assure that the most effective measures are used to enhance all of the benefits which are to be realized from the stream.

Selic Canyon Creek (Suspected)

The BLM administers lands along approximately one mile of Selic Canyon Creek's seven mile drainage. Those lands are located in T37 N, R15 E, Sec. 1, MDM. The stream joins Cedar Creek in Section 15; then flows to the west and discharges into Tule Lake Reservoir. Selic Canyon Creek has been observed as having high turbidity and streambed sedimentation in ponds and side waters. These conditions are associated with good bank conditions and channel stability. Grazing on BLM administered lands is thought to be a causative factor in affecting these conditions.

Selic Canyon Creek has a recorded flow of one cfs. (.03 cms) in September, and averages five feet wide, and three inches deep.

Effects On Beneficial Uses: This small mountain stream has a limited capacity for supporting a cold water fisheries. The stream's natural character provide little habitat for trout. However, beaver ponds provide suitable living space in the stream. Resident as well as migrating rainbow trout from Cedar Creek, are capable of spawning in segments where the gravels are kept fairly clean. Beaver also perpetuate an ill-effect by removing the riparian aspen shade canopy.

Information Needs: Monitoring for sediment conditions in both the streambed and the water would be necessary in order to identify the source and trend of the sediments impacting the stream.

Payne Reservoir Area (Existing)

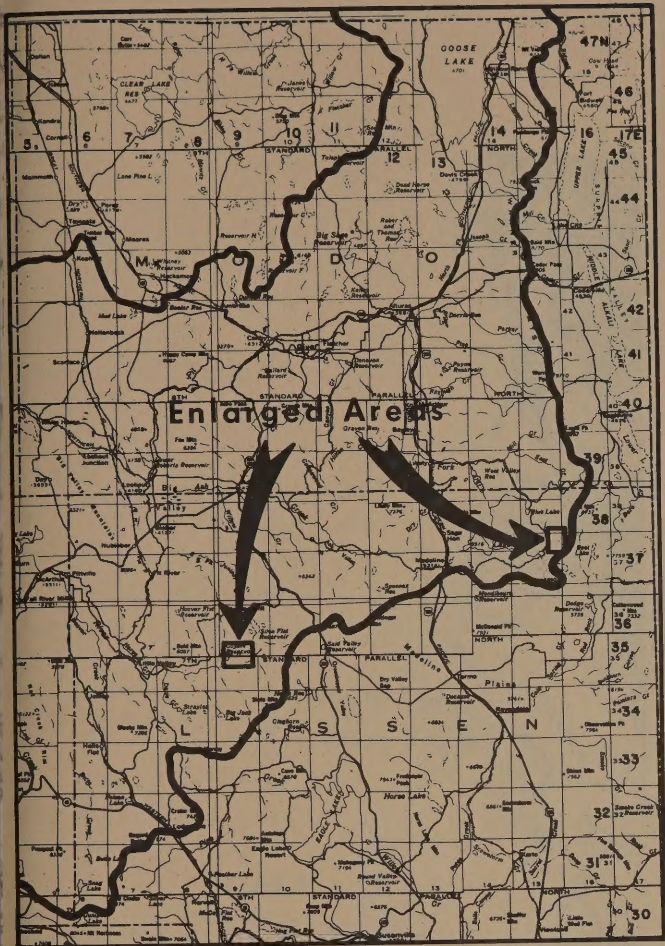
The rangeland in the general vicinity of the Payne Reservoir is drained by Jim and Fitzhugh drainage systems. Most of the land identified as T40

and 41N, R13 and 14E, MDM, is in contiguous public ownership. Many of the reservoir construction and access roads have been located along tributary drainage ways. Although some of the roads were originally formed by walking a crawler tractor to the constuction site, they have since been used by light vehicles for various purposes. These and other roads in the area have been used in a manner which has exceeded their design function. Such practices have resulted in washouts at stream crossing locations and diversion of runoff onto the road surface. Gullies, several feet deep, have formed in some cases. These gullies are a good indicator that sediments have been delivered to Jim and Fitzhugh Creeks during major runoff events.

Effects On Beneficial Uses: Both streams flow westerly and supply reservoirs and irrigation channels before being discharged into the South Fork of the Pit River. The effects of the deteriorating road conditions on the agricultural water supply is unknown. Since Fitzhugh Creek is impacted by other practices (see Low Flow Diversions and Grazing) it is difficult to generalize about the source and impacts of the turbidity levels observed in Fitzhugh; however, biologists feel that generated sediments are detrimental to the cold water fisheries habitat.

Information Needs: An extensive high-flow monitoring system would be required to determine the specific impacts of the roads. In additon a through road reconnaissance would be necessary to pinpoint problem locations. Considering that the Habitat Management Plan recommends that the roads be closed to traffic, a reconnaissance to drain the roads may be all that is necessary to mitigate future impacts.

Pit River Hydrologic Area

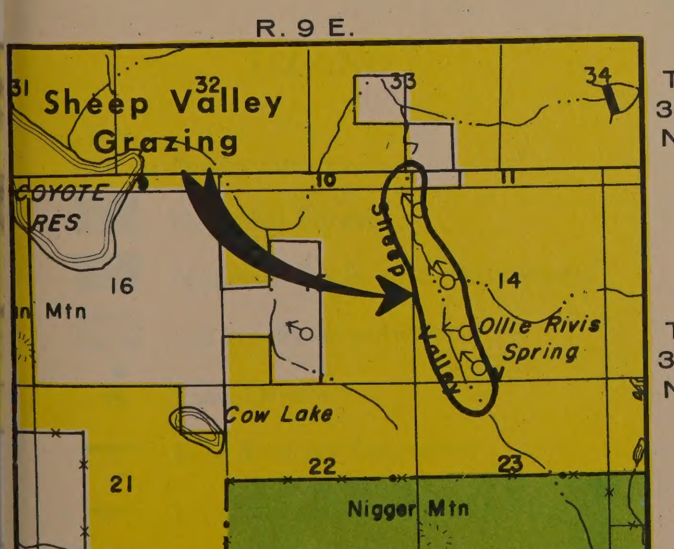


U.S. Bureau of Land Management
SUSANVILLE DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

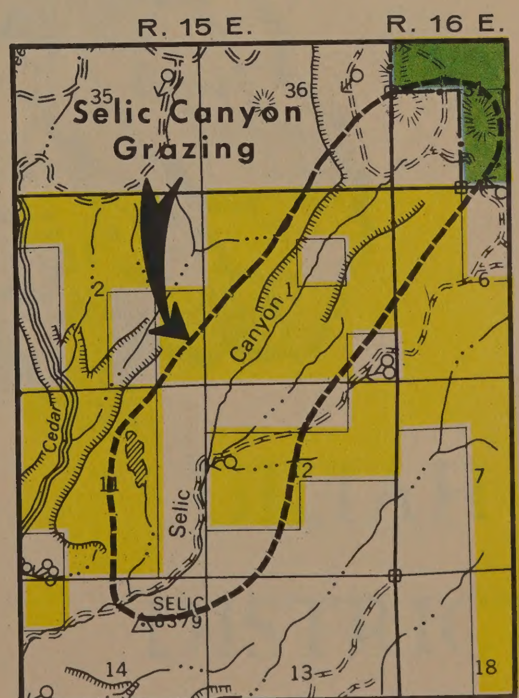
SELIC CANYON & SHEEP VALLEY

LEGEND

- Existing Problem Area
- Suspected Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands



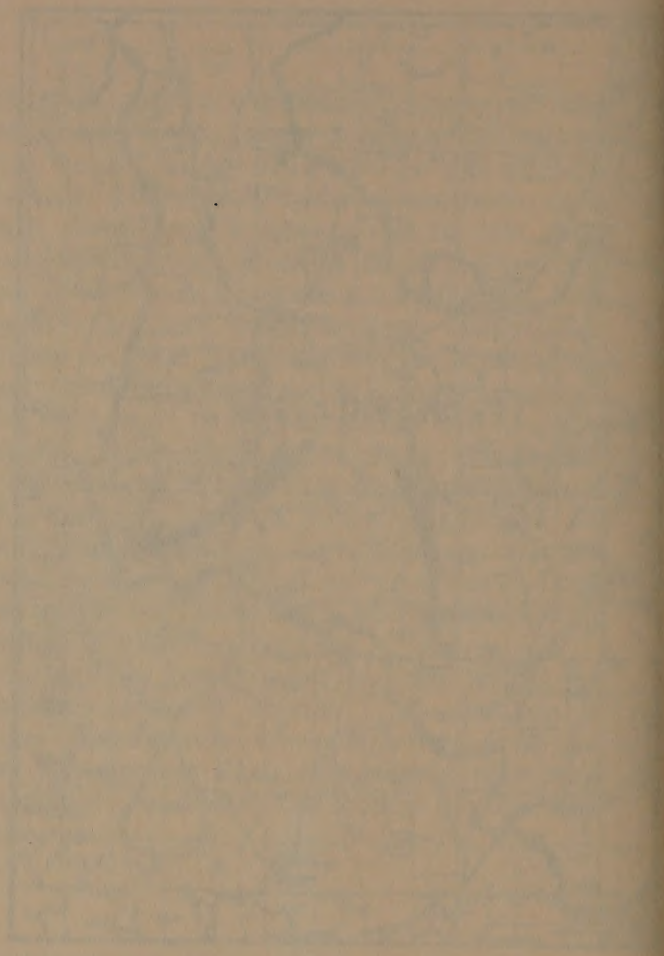
1 Inch = 1 Mile

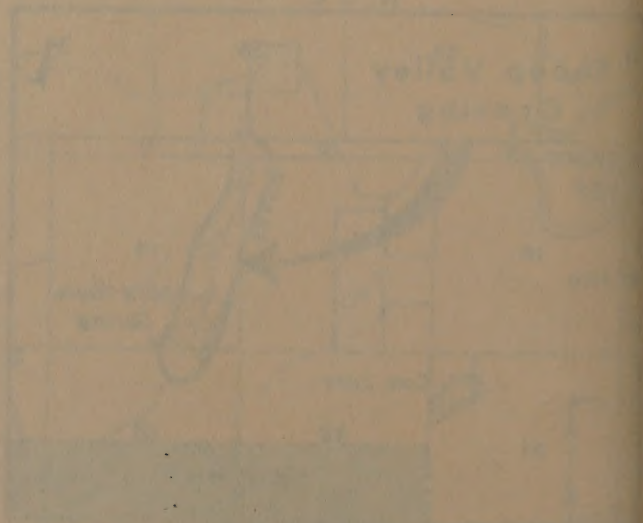


1 Inch = 1 Mile

Diablo Base and Meridian

Figure 3-54





UKIAH DISTRICT

Figure 3-55

UKIAH DISTRICT

The Ukiah District is located along the north coast of California, extending from the Oregon border south to San Francisco. The BLM manages tracts of Public Lands in portions of 13 counties west of the Sacramento River which are included in three Resource Management Areas; totalling approximately 500,000 acres (202,350 ha). The district's management area overlaps three Water Quality Control Board Regions (1,2, and 5). Eight Hydrologic Areas have been deliniated on figure 3-55 for the discussion of identified problems. The boundaries of these areas approximate those deliniated by the State Water Resources Board.

The district consists primarily of mountainous terrain with many separate ranges, coalescing mountain masses and several major structural valleys. The district lies partly within the Klamath Mountains and partly within the Northern Coast Ranges geomorphic provinces. Elevations vary from sea level to nearly 6,000 feet (1829 m) in the Coast Ranges up to 9,000 feet (2743 m) in the Klamath Mountains.

Drainage is generally from east to west in the Klamath Mountains, the drainage pattern is mainly dendritic and streams and rivers flow transverse to structure and lithology in deep, narrow canyons, having established their courses before orogenic movement occured (antecedant or insequent). Along some reaches of the major rivers, flow is controlled by structure and fabric (consequent). Abundant evidence of Pleistocene glaciation exists at higher elevations.

By contrast, elevations in the Northern Coastal Ranges are lower, with the principal rivers being the Van Duzen, Eel, Mad and the Russian. The province is characterized by elongated, northwest-trending ridges that are approximately parallel to the structure and lithology of the area. The drainage pattern is mainly trellis; that is, the major streams and rivers parallel the structural and lithic trend, following local zones of weakness, strike or dip (consequent or subsequent). With the exception of the Russian River, which flows southeastward toward San Francisco Bay, the principal rivers flow to the northwest. The longest and highest ridge in the province (the drainage divide between the Sacramento and the Northern Coastal Ranges provinces) has a north-south orientation and exhibits some remnants of Pleistocene glaciation.

Rocks of the Klamath Mountains are largely crystalline, consisting of highly metamorphosed volcanic and sedimentary rocks intruded by granitic and ultramafic rocks. Rock types encountered include: greenstone, hornblende and quartze-mica schists, mildly metamorphosed shales, sandstones, cherts, limestones, mica schists, and greenschists.

The Northern Coastal Ranges are made up of a complex assemblage of sandstone and shale and greenstones intruded by masses of mafic and utramafic rocks mostly altered to serpentine. Landsliding is a widespread occurrence throughout the Northern Coastal Ranges. A distinct type of landslide; i.e., the earthflow type has developed from this severely folded, faulted and crushed terrain. Earthflows are generally shallow but may take in a large areal extent.

In both provinces strata most commonly dips eastward. In the North Coast Ranges principal structures appear to be northwest trending strikeslip faults of the San Andreas system and subparallel folds. The boundary between the two provinces is a high-angle reverse fault on the west and a transverse fault on the south. The arcuate arrangement of the lithic belts of the Klamath Mountains results from forces from the east with the boundaries between lithic belts being chiefly reverse faults that dip eastward.

The principal activities within the district include timber management, geothermal development and to a lesser extent wildlife management, grazing, and various forms of outdoor recreation. All of these utilize or affect water in some way. Particular emphasis is placed on the Smith River, Klamath River, and Trinity River systems which are the major streams draining the district and discharging into the ocean. As such, they support major runs of anadromous fisheries, as do all the major streams in the district. These three rivers, along with the Eel and Van Duzen River systems have been designated for classification as "Scenic and Wild Rivers" by the State. The BLM recognizes the importance of these values and incorporates the unique values in its management discussions. Throughout the district the surface waters are managed as a multiple use resource.

Grazing activities cover about 88,000 acres (35,614 ha) which are leased to ranchers for cattle and sheep. This, along with the harvesting of approximately 14 million board feet (2.4 million cu. ft.) of timber each year and geothermal development leasing, provides a direct benefit to the local communities. Water quality problems within the district can be placed into two categories: those related to natural conditions or problems; i.e., landslides, erosion from burned areas, downcutting streams, natural pollution from mineral springs etc., and those related to man-caused or man originated conditions or problems; i.e., erosion from timber harvest areas, pollution to streams related to geothermal development such as erosion from roads etc., pollution to streams related to recreational use of public lands etc.

Management Activities

Grazing

Contamination of drinking water on Public Lands is a recurring problem. On BLM administered lands the source of contamination is usually a result of human activity in the proximity of the water source, or from livestock and wild animals which are attracted to the lush vegetation around springs and tanks. While there may be several water sources which have the potential for contamination, five sites are suspected of already being contaminated. They are located as follows: T1S, R11W, Sec. 4 (near Shell Peak); T14N, R11E, Sec. 23 (between Tucker and Willow Ridges) and Section 25 & 26 (near Buck Ridge); T13N, R10W, Sec. 28 & 29, all of the Mount Diablo Meridian. Contamination from fire caused sediment transport is suspected of entering the South Fork of Scotts Creek in T14N, R10W, Sec. 4 & 33, MDM.

County health department records should be reviewed and samples should be taken to determine the actual quality of the water. Where contaminated, the site should be reviewed for mitigative recommendations.

Silviculture

Silvicultural activities along the northcoast of California involve a complex interaction of variables. Not only does it require the manipulation of some of the largest timber in the nation but also involves the most erosive and unstable landscape. Due to the degree of natural instability and the size of the equipment required, most logging operations and associated road construction have the potential for creating impacts on nearby streams. The use of ground skidding equipment on steep slopes, roads constructed on steep slopes or in fault zones, and any logging near streams would be of greatest concern. Cost effective techniques have been developed which allow silvicultural activities to be conducted without causing a significant negative impact on water quality.

Typically, the introduction of sediment from an operational area to a stream channel is the most common pollutant which could result from harvesting activites. Thermal loading of a stream by removing the shade producing vegetative canopy, has been considered a detriment to stream quality. Although if properly designed, a certain amount of increased temperature and light may be beneficial to fisheries habitat. Large and fine organic intrusion into the stream ecosystem is another major consequence which has generally occurred in the past.

In order for site specific recommendations to be made a coordinated on site review by at least the district hydrologist, forester, and contractor; and probably the soil scientist, geologist, and biologist will be necessary. The district engineer should be involved where roads and landings are a part of the operations. The problems encountered are extremely diverse and cannot be generalized, nor are there general solutions.

Due to the extremely high backgound levels of sediment, the extreme flucuation from high to low flow, and diversity of solar insolating conditions; bracket monitoring of operations will provide the needed information to insure compliance with the goals of P.L. 92-500.

Geothermal Development and Mining

Geothermal development is proceeding rapidly on public lands, mineral reserve lands and private lands within the district. The Geysers KGRA produces more power than any other area of geothermal development in the world. Mining activities are widespread throughout the North Coast, while several locations were identified, none were reported to be on or affecting BLM administered lands. Mining, as with any major earth moving project and particularly those involving heavy or toxic minerals, has the potential for creating water quality problems if not properly designed.

Recreation and Wildlife

Various portions of public lands receive considerable recreation use including: ORV, hunting, fishing and camping. The amount of use is proportional to ease of access from major population centers. The BLM maintains eight campgrounds, four of which are located between Ukiah and Clear Lake and the remaining four are in the King Range. Several primitive

camping areas are used to a lesser degree. There are several potential wilderness areas within the district.

In 1970 congress created the King Range National Conservation Area. The BLM prepared a multiple use and sustained yield management plan which was approved in 1974. Through the acquisition process not only were many private parcels put under public ownership but the existing problems were also inherited as described later in this chapter.

Roads

Associated with nearly all man-caused problems are access roads, ORV trails, fire roads etc., which are in themselves a major cause of degradation of water quality. Research into the construction of low volume roads on the unstable coastal terrain is critically lacking. Currently major efforts are being directed to a better understanding of the mechanisms of slope failure in these ranges. Roads of all design levels from four-lane highway to ORV trails have been noted to be associated with the severe slope instability problems.

Natural Erosion

Throughout the Coast Range of Northern California naturally high erosion and sediment discharge rates have been documented. An area along Honeydew Creek and two areas along the Van Duzen River were identified by Ukiah District personnel as being of particular concern.

A naturally occuring landslide along the west fork of Honeydew Creek in T3S, R1W, Sec. 22, 27, HM. is delivering great quantities of sediment to the creek.

In the Van Duzen drainage, the Eaton Roughs area (T2N, R4E, Sec. 25, 26, HM) and the Sweasy Lake area (T1N, R4E, Sec. 1 &2 HM.) exhibit severe instability on BLM administered lands. The stream corridors at these locations are within the "Scenic" portion of the river.

Aesthetic, recreation and fishery values are undoubtedly effected by sediment delivery and associated turbidity resulting from slope failures along these rivers. While reduction of natural erosion rates would have a short term beneficial effect on these uses; it would probably be counter productive in the long run by disrupting the dynamic equilibruim of the natural geologic and erosional processes. Conversely, accelerated eroison rates would be equally disruptive.

Much more research information is required before there is a sufficient understanding of the sediment generation-delivery-discharge dynamics to recommend major enhancement projects. On the other hand, a site specific review may be all that is required to prescribe measures to avoid increasing erosion from specific activities.

Awareness is the first step toward partial or complete alleviation of water quality problems. Current efforts need to be directed toward 1)

defining existing problems, 2) under-standing natural processes and conditions, and 3) and active involvement in lessening or abating existing problems for which there is a solution.

Eel River Hydrologic Area

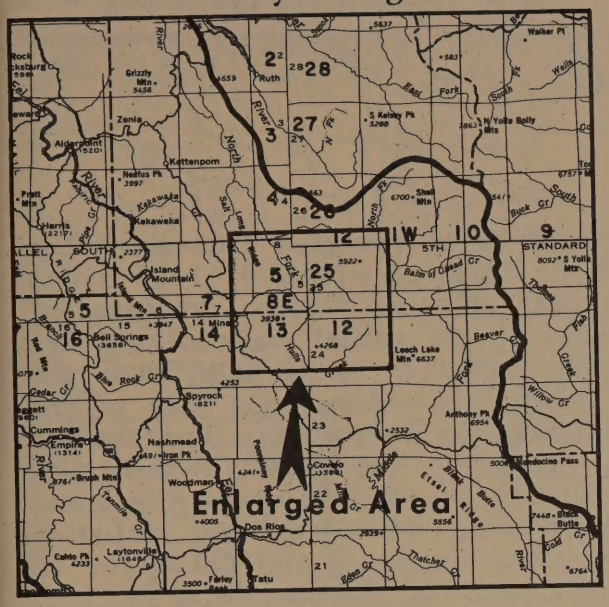
The Eel River drainage network, which includes 3,905 sq. mi. of watershed, is the most extensive on the North Coast of California. The Eel River has its headwaters near Lake Pillsbury and flows northwesterly draining portions of Mendocino, Humboldt, Trinity, Lake and Glenn Counties and eventually discharges into the ocean about 15 miles (24 km) south of Eureka. In addition to the three major forks, the Van Duzen River is included in the system.

The BLM administers contiguous and scattered blocks of land throughout the drainage with very little land located immediately adjacent to the four major drainages. Most water quality problems are restricted to headwater tributaries. These lands are included in the East Mendocino Planning Unit, Red Mountain Planning Unit, Russian River Planning Unit, Mad River Planning Unit, and Humboldt Planning Unit. Virtually all varieties of district management activities can be found in this Hydrologic Area. There are considerable timber resources, extensive grasslands, one of the finest steelhead and salmon fisheries in the state, diverse recreational opportunities, and commercial sources of minerals. The uses which would be most directly effected by degradation of the quality of the waters of the Eel River system would include; contact and non-contact recreation, fisheries, and to some extent domestic water supply.

The major difficulty which is encountered when managing for water quality in this and other coastal drainages is determining acceptable or background levels of sediment delivery. Under natural conditions the drainages fluctuate from extreme low flow to extreme flood stages. The Eel River at Scotia, for example, has recorded summer low flow at 10 cfs (.3 cms), and the 1964 flood exceeded 752,000 cfs (21297 cms). Since this gauging station is downstream from all of the activities in the basin it is difficult to separate cultural effects of the natural process or even whether the impacts are significant. However, annual sediment discharge from the Middle Fork ranged from 777 to 25,100 tons per square mile (272-8792 T/km^2). This gives some indication of the magnitude of yearly fluctuation that might be expected on a North Coast rivers which are relatively undisturbed. Furthermore, following the 1964 flood, the California Department of Fish and Game noted that all of the pools (about 200) were filled with sediment and steelhead populations were almost wiped out. However, nine years later the drainage had cleaned itself and fish populations had recovered.

Due to this type of ambiguity, most of the problems addressed have impacts on water quality with unknown degrees of significance. Site specific judgement on the part of the district's staff (along with water quality monitoring) will provide the best means to maintain or improve water quality.

Eel River Hydrologic Area



U.S. Bureau of Land Management
UKIAH DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

NORTH FORK EEL RIVER

LEGEND

- Suspected Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands
- Indian Lands

Figure 3-56

Grazing

North Fork Eel River (Suspected)

The BLM administers approximately ten miles of riparian land along the North Fork of the Eel River and several tens of miles of land along perennial tributary streams in the area north of Round Valley. The area of concern extends several miles on each side of the mutual Humboldt and Mt. Diablo meridians, and can generally be described as T25N, R12W, MDM. and T5S, R8E, HM. Grazing adjacent to the North Fork channel has lead to the suspicion that this activity may be contributing sediment to the channel through the process of sheet and gully erosion. The potential for such problems to develop from overgrazing generally exists throughout the area. The area is characterized by typical Franciscan melange topography including massive slump basins, scarps, and disected drainages. The Eel River is noted for its high annual sediment loads with an apparent high ability to entrain sediments in the major forks and tributaries. These combined features have provided the steelhead spawning habitat which has been described as one of the finest in California.

Effects on Beneficial Uses: The famed steelhead fishery is dependent upon the maintenance of spawning habitat. The contribution of sediments at the time when eggs or fry are developing in the gravels can cause significant losses.

The fine and amorphous sediments often asssociated with the drainage also lead to a deterioration of aesthetic water quality through high turbidities.

Information Needs: In order to clarify whether the impacts to the river are significant or even detectable above natural background levels a synoptic monitoring program should be initiated for water quality. Sampling for sediments and turbidity should be carried out during periods of fisherman use and during periods critical to maintenance and reproduction of the fish population.

Low Volume Roads

Elk Horn Ridge (Existing)

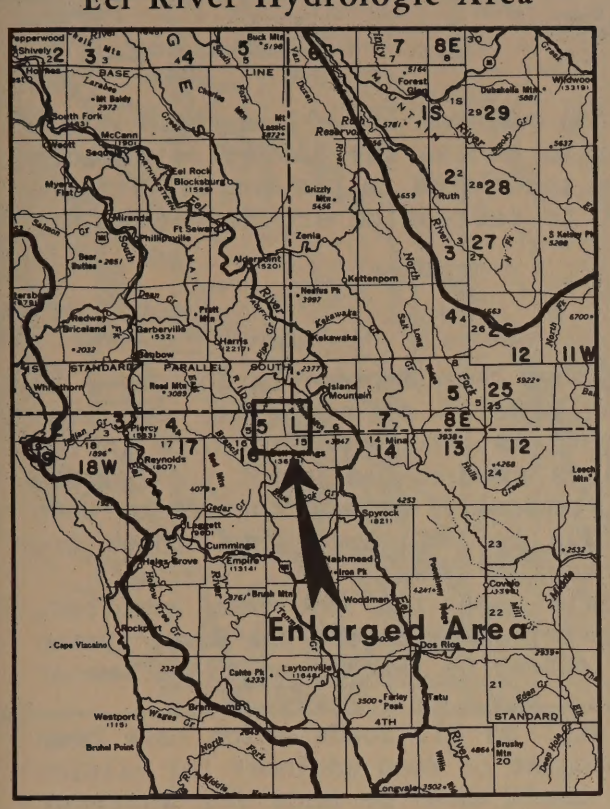
The road in the area of Elkhorn Ridge provides an example of the problems encountered prior to recent advancements in steep-ground road construction techniques. A section of road located in T22N, R16W, Section 20 MDM has failed as a result of slope instability.

As stated previously, slips, slides and slumps, are a problem throughout the North Coast on all levels of design, even major highways.

Areas designated as having the greatest potential of failure should receive special attention. One such area was reported by the district in section 18 of the same township. Another, a logging road, was reported in T24N, R16W, Sec. 5,9 & 17 of BLM administered lands.

Effects On Beneficial Uses: The beneficial uses which would be affected includes all of those previously cited for the Eel River drainage; namely fisheries and recreation. Various tributaries to the South Fork of the Eel River would be most directly influenced.

Information Needs: Members of the resources and operations staff, including the district hydrologist, geologist, soil scientist, and engineers



U.S. Bureau of Land Management
UKIAH DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

CHARLTON CREEK

LEGEND

Existing Problem Area

Patented Lands

Public Lands (BLM)

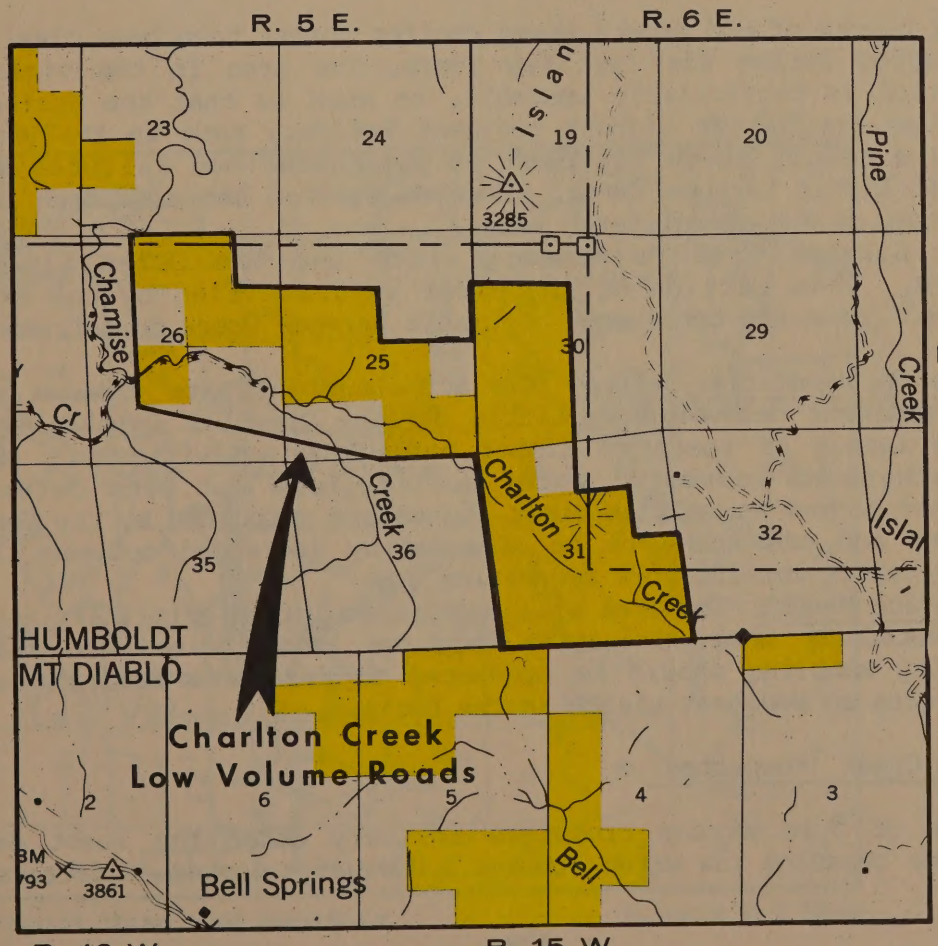


Figure 3-57

engineers should review sites with existing problems as well as those with a high potential of future problems. To assess the causative factors involved and to prescribe cost effective techniques to prevent or mitigate those problems, sampling with respect to recreation and fisheries may be conducted.

Charlton Creek (Existing)

Generally, old logging roads which have been improperly abandoned to traffic or maintenance, tend to have erosion or stability problems associated with them. Uncontrolled runoff is often a major force in the process. An example of this situation is exhibited adjacent to Charlton Creek in T5S, R5E, HM. The soils are typically subject to erosion when water is concentrated. Uncompacted fills on the steep side slopes are particularly prone to gullying from uncontrolled runoff.

Effects On Beneficial Uses: Specific uses have not been reported, however, Charlton Creek is a first order tributary to the Eel River system and high sediment loads may have some effect on downstream fisheries or recreational uses.

Information Needs: This road, as well as all roads which have been abandoned, should be reviewed by a hydrologist or road engineer for exising problems. Practical recommendations could then be made for whatever abatement measures would be necessary.

Little Larabee Creek (Existing)

Several blocks of old growth mixed conifer forest have been clearcut and highlead yarded during the last few years. The area in the vicinity of Larabee Buttes is particularly unstable, so much so that the drainage has been cited as having the highest sediment delivery rate in the Van Duzen Basin. As a result there has been considerable road failures along a tributary of Little Larabee Creek. Surface erosion has also been reported to be occuring on BLM administered lands.

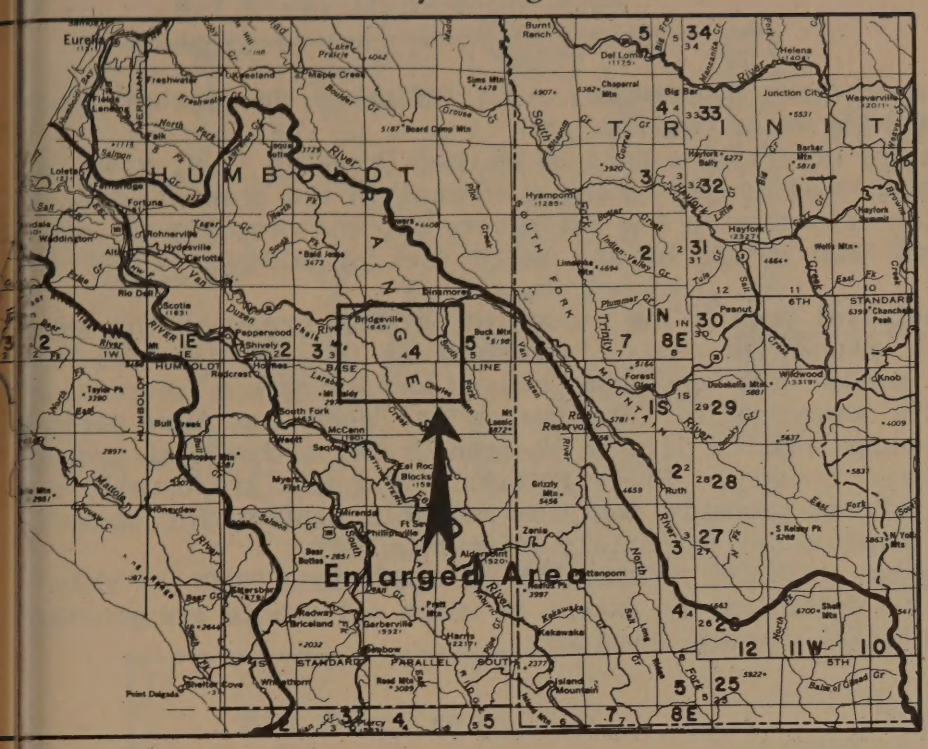
Little Larabee Creek discharges into the Van Duzen River near Bridgeville. This section of the River is classified by the State as "Recreational" from the confluence of Little Larabee Creek downstream to the mouth.

Effects On Beneficial Uses: The actual impacts are unknown and the amount of sediment delivered to Little Larabee Creek or to the Van Duzen River as a result of roads or timber harvesting activities are unknown. Natural background levels of water quality have not been determined. Steelhead and salmon as well as other fishes are supported by the Van Duzen River system and are known to be effected by increased sediment levels. This area receives considerable recreation use.

Information Needs: The area will require an interdisciplinary review in order to determine what mitigative measures are required and feasible. Water quality sampling should be conducted to determine natural and man-induced effects on sediment yields in the basin.

Woodman Creek (Suspected)

The use of ford stream crossings are very often the least damaging technique for crossing low water streams. However a number of factors, e.g.



U.S. Bureau of Land Management
UKIAH DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

LITTLE LARABEE CREEK

LEGEND

~ Existing Problem Area

Patented Lands

Public Lands (BLM)

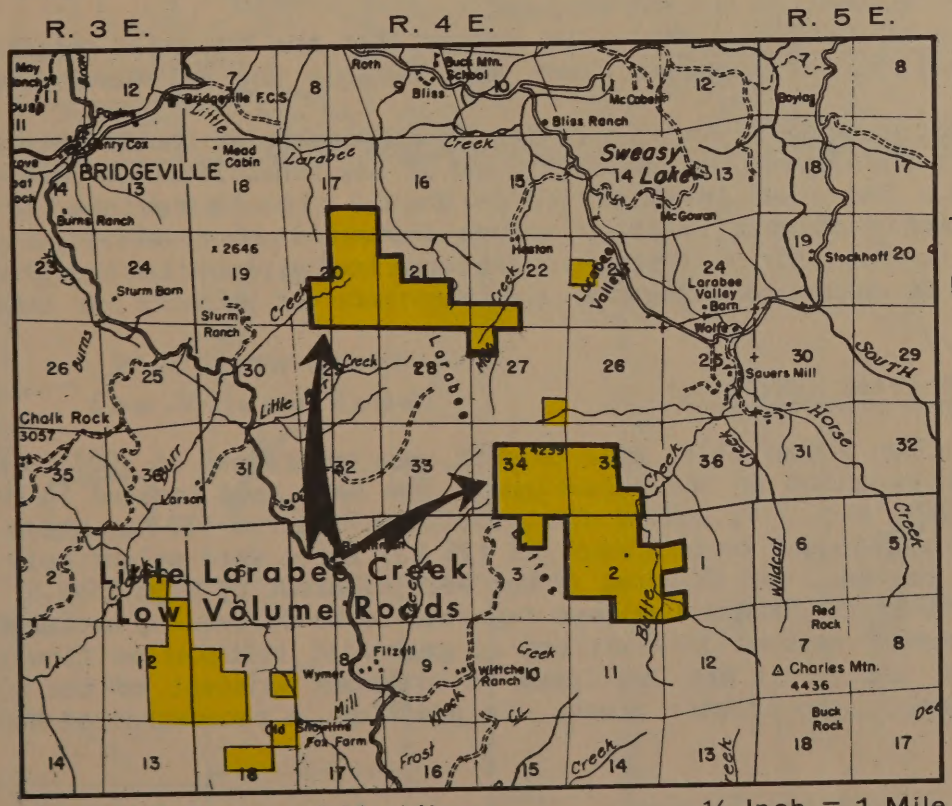


Figure 3-58

time of year, bed condition, approaches, etc., influence the appropriateness of fords for maintaining water quality.

Logging trucks are utilizing a ford on Woodman Creek in T22N, R14W, Sec. 20, MDM which is suspected of generating sediments in the channel. Woodman Creek is a perennial tributary to the Eel River, but the crossing is located in the intermittent head waters of the south fork of Woodman Creek five miles away.

Effects on Beneficial Uses: The impact of Woodman Creek on the waters of the Eel River in unknown but due to high sediment levels in the Eel River during the rainy season the greatest impact on downstream recreational activities would be expected in late spring or other low flow periods. There is no known water quality data on Woodman Creek, although it probably supports a cold water fishery. Since tributary channels are usually used for spawning this stream probably contains suitable habitat for spawning. The effects of the ford on any potentials is unknown.

Information Needs: Bracket monitoring of operations such as this is necessary in order to determine the extent to which pollutants are generated and impacts on beneficial use are involved.

Silviculture

Thatcher Butte (Existing)

The 1974 Thatcher Butte timber sale is located in T29N, R11W, Sec.1, MDM. The area was selectively harvested using lateral tractor yarding techniques. In spite of appropriate erosion control stipulations in the contract, a crawler tractor traversed a steep slope into a creek. Subsequently, the trail eroded sediments into the channel and plugged a culvert. The plugged culvert allowed runoff to breach the road fill, eventually washing out the road. Much of the material delivered to the channel are evident in transit storage.

Effects on Beneficial Uses: It appears that the fisheries potential and recreational use of Thatcher Creek and possibly the Eel River have been affected.

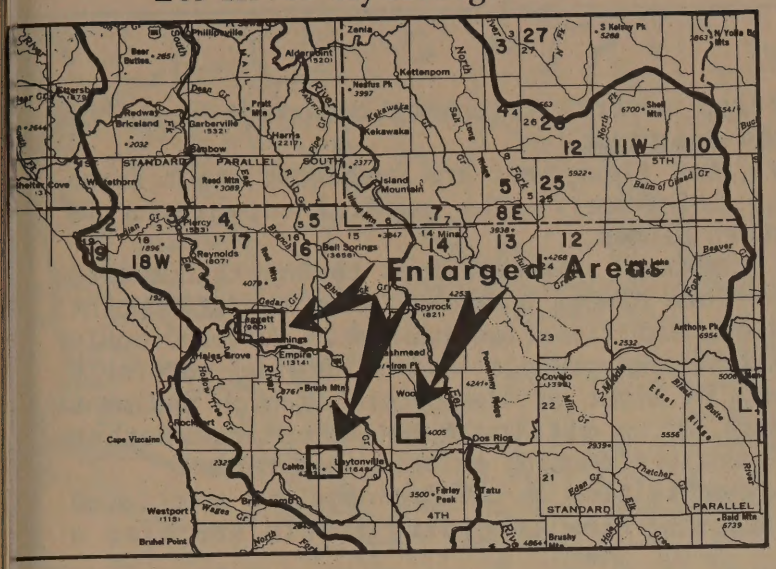
Information Needs: An area review by a hydrologist should determine to what extent the channel is recovering and if any rehabilitative measures are necessary. The road drainage design should also be reviewed with the engineer and a culvert inlet structure installed if required to prevent future plugging. Since sediments are continuing, monitoring should be conducted in order to determine the magnitude of effects on beneficial uses.

Big Dan Creek (Existing)

The Big Dan Timber Sale, near Leggett, was contracted in 1971 to harvest timber from portions of three sections. The sale area located in portions of T23N, R16W, Sec. 7,8, and 18 MDM., included 74 acres (30 ha) where 70-80% of the fir was logged by highlead, 63 (25 ha) acres were selectively logged by crawler tractor, and 18 acres (7 ha) were clearcut by high lead.

Active surface erosion has been reported to be delivering sediments into Big Dan Creek. Several intermittent or perennial tributaries flow through the harvest units and Big Dan Creek is situated adjacent to the clearcut area and one of the tractor areas. In addition, a reconstructed haul road

Eel River Hydrologic Area



U.S. Bureau of Land Management
UKIAH DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

WOODMAN CREEK, BIG DAN CREEK, & CAHTO PEAK

LEGEND

- Existing Problem Area
- Suspected Problem Area
- Patented Lands
- Public Lands (BLM)

Big Dan Creek Silviculture

Woodman Creek Low Volume Roads

Cahto Peak Fire

Mt. Diablo Base and Meridian

1 Inch = 1 Mile

Figure 3-59

crosses the main channel; this and several tributary crossings could be influencing sediment levels in the drainage.

From the sale area, Big Dan Creek flows west and southwest about three miles ot the South Fork of the Eel River. The general topography is considered to have moderate to steep slopes.

Effects On Beneficial Uses: Sediment contributions to the tributaries and upper reaches of the Eel River are always a concern from the standpoint of the effects on salmon and steelhead fisheries habitat. As previously discussed sediments can cover spawning gravels and otherwise adversely effect aquatic habitat. However, in light of the naturally high sediment levels in the Eel River drainage it is difficult to determine whether increases in sediment are significantly effecting existing habitats.

Since the various recreational activities in the drainage are associated with contact and aesthetic uses, low flow turbidity levels are also a concern.

Information Needs: A site review by a hydrologist should identify specific causative conditions responsible for the sediment generation and transport. If these conditions are contrary to BLM policy or if they are significantly effecting beneficial uses of the stream, mitigative measures could then be prescribed. Initial runoff, high flow, and low flow stream sampling which brackets the operations and the confluence with the Eel River would provide an estimate of the significance of the impacts resulting from the operation.

Surveyors Canyon (Existing)

The Surveyors Canyon Timber Sale which involved portions of Sections 7,8, and 18 of T22N, R16W HM., included 418 acres (169 ha) which were selectively harvested in 1959, 1960 and 1961. To supplement the residual stand and natural regeneration. The area was replanted in 1966. Erosion gullies and at least one road wash out have been observed in the sale area. The gullying is thought to still be in an active state. If this is the case, i.e. accelerated erosional processes have not stabilized after 17 years, the level of sediment delivery to the Surveyors Canyon Creek is probably very significant.

Three major forks of the Surveyors Canyon drainage flow across the sale area and join just downstream, then flow less than one mile across private land before its confluence with the South Fork of the Eel River.

Effects on Beneficial Uses: Aside from providing aquatic habitat there are no other known uses of Surveyors Canyon. However, the Eel River's heavy recreation use should be considered when assessing impacts and prescribing treatment in the area.

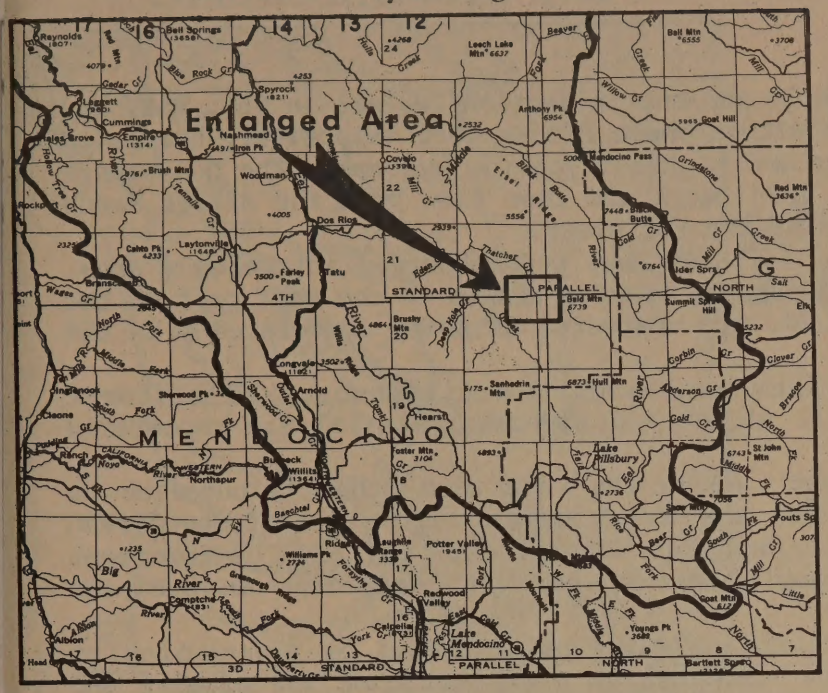
Information Needs: A hydrologist needs to review the area to verify the level of accelerated erosional activity. In the North Coast, accelerated erosion from logging activities usually stabilizes within a few years. Once a reasonable degree of stabilization has occurred, care must be exercised not to reactivate erosion by major "clean-up" operations.

A monitoring program would assist the hydrologist in making the determinations required in this particular situation.

Tom Long Creek (Existing)

The Tom Long Timber Sale involved several 40's in Sections 28 and 29,

Eel River Hydrologic Area



U.S. Bureau of Land Management
UKIAH DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

THATCHER BUTTE

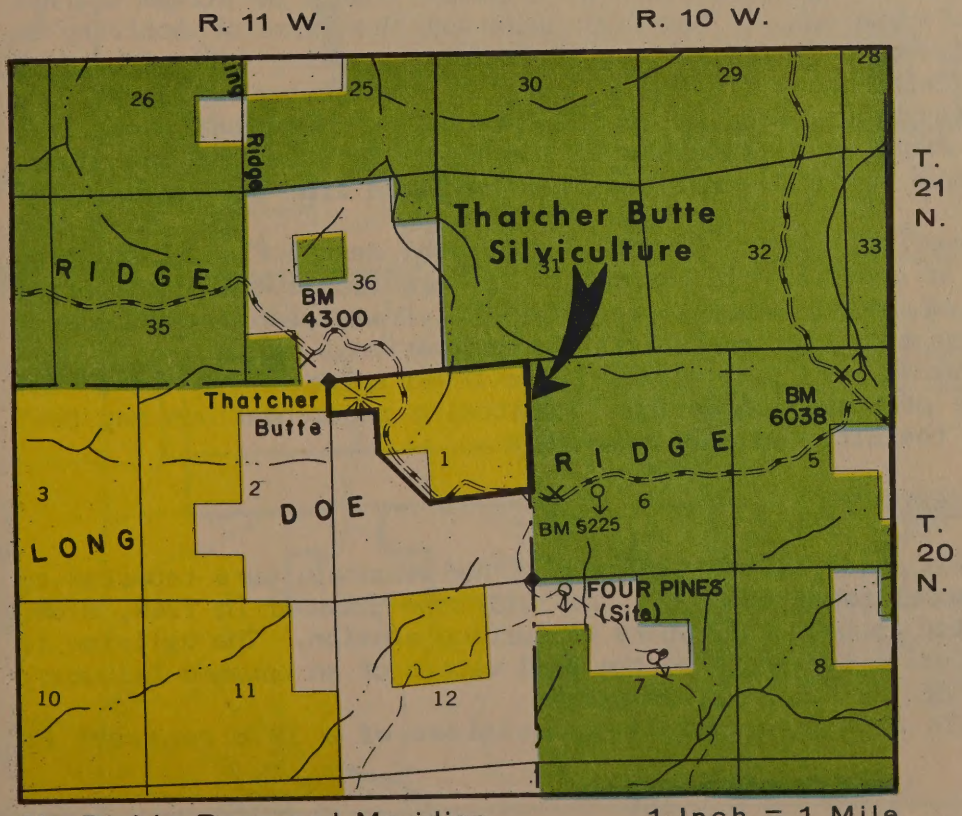
LEGEND

~ Existing Problem Area

Patented Lands

Public Lands (BLM)

National Forest Lands



Mt. Diablo Base and Meridian

1 Inch = 1 Mile

Figure 3-60

plus a detached 40 in Section 19 and one in Section 20; all in T5S, R5E, HM. From 1963 to 1965, 286 acres within these blocks were selectively harvested with a combination of tractor and highlead yarding systems. The headwaters of Tom Long Creek drain the main block and then flow past the Miller Ranch before joining the South Fork of the Eel River.

Erosion gullies and slope failures have been observed in the sale area. Due to the layout of the logged area, tractor trails in the east part of the unit, as well as in section 20, are suspected of being associated with the problem.

Roads were also identified as being an active source of sediment delivery to the stream. Fill slopes and sidecast material are reportedly still actively eroding.

Effects on Beneficial Uses: As is the case with other tributaries to the Eel River system, recreation and fisheries are major uses of downstream waters. In addition, domestic and agricultural uses may also be important where increased filtration would be required with increases in sediment load.

Information Needs: The area should be reviewed by a hydrologist accompanied by a forester, to identify the exact cause of the problem and the magnitudes involved. If deemed necessary a monitoring program should be established to identify levels of impacts on beneficial uses.

Brush Mountain (Existing)

A first order tributary of Grub Creek which is located in T22N, R16E, Sec. 3, MDM, was reportedly used as a skid trail in a past logging operation. Normally, the practice of locating skid trails in perennial drainages is not considered acceptable. Such activity can detrimentally disrupt the spawning gravels and expose or crush redds. Bank damage and releasing of entrained sediments are also a common result of stream channel tractor skidding. However, it has been observed that tractor activity on a low gradient stream at a time when gravels are not being utiized by fish can be the least detrimental alternative in a limited number of situations.

Grub Creek discharges about three miles from the operational area into Ten Mile Creek, which is a tributary to the South Fork of the Eel River. The operational area is about ten river miles upstream from the community of Leggett.

Effects on Beneficial Uses: On site, mechanical destruction of spawning gravels would be of concern, but the current or previous spawning potential of that section of stream channel is unknown. Downstream impacts could include a reduction of fisheries habitat and recreational values.

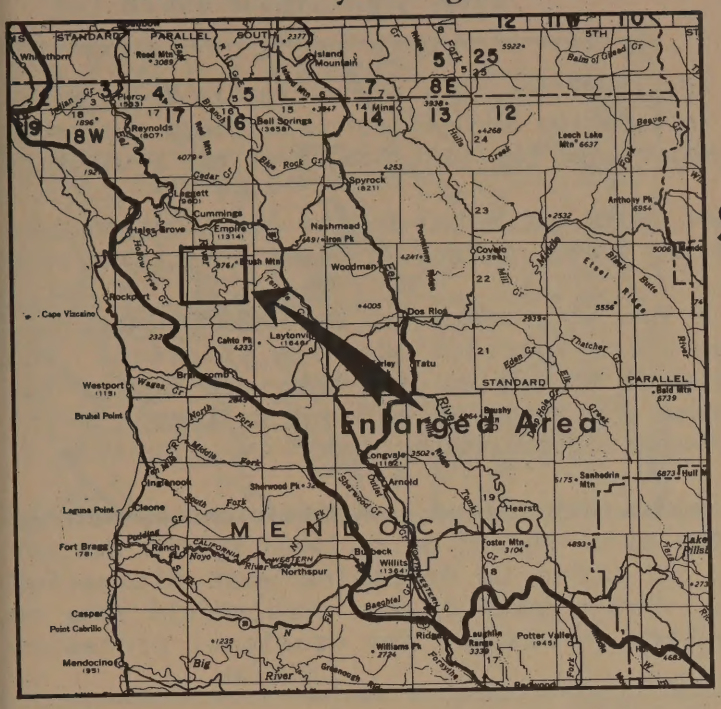
Information Needs: The area should be reviewed to determine the actual impacts which are presently occurring. Monitoring recomendations may best be made following the site specific assessment.

Red Mountain (Existing)

Two timber sale areas in the vicinity of Red Mountain were reported to be experiencing accelerated erosion. The old sale located in T24N, R16W, Sec. 6, was reported to have indicators of surface erosion. The gullying is suspected of delivering sediments to the head waters of an unnamed tributary to the South Fork of the Eel River drainage.

The other sale area is under the provisions of a 1978 contract to

Eel River Hydrologic Area



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UKIAH DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

ELKHORN RIDGE (SOUTH), SURVEYORS CANYON, & BRUSH MOUNTAIN

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)

R. 17 W. R. 16 W.

T. 23 N.

T. 22 N.

Surveyors Canyon Silviculture

Low Gap Creek

Surveyors Canyon

Lynch Cr.

Creek

Brush Mountain Silviculture

Tenmile Creek

CAMP SEBOW

Horseshoe Bend

Fox Cr.

WILDERNESS LODGE

Elkhorn Ridge (South) Low Volume Roads

Black Oak Mtn.

Butler Mitchell Cr.

Elder

VABM 3761

RIVER

MOUNTAIN

Elk

Mt. Diablo Base and Meridian

1 Inch = 1 Mile

Figure 3-61

include timber harvest and road construction. The activities in T24N, R17W, Sec. 1 & 2 were reported to be influencing unnamed tributaries on the north end of Red Mountain which discharges into the East Branch of the South Fork of the Eel River.

There have been several other units harvested in the Red Mountain area which were not reported to have any water quality problems associated with them.

Effect On Beneficial Uses: The interaction of several factors will determine the actual extent to which specific uses are effected. The fisheries resource and recreational activities are the uses having the highest priority of concern. Timing and rates of sediment delivery are the two factors which have the greatest effect on the types and magnitude of impacts realized.

Information Needs: As is prudent with all of the situations associated with silvicultural operations, the sites should be reviewed by the distict hydrologist and area forester in order to determine what mitigation measures, if any, are required. Other units in the area should also be visited at the same time to better understand the erosional processes operating in the hydrologic area.

Fire

Cahto Peak (Existing)

Tractor constructed firebreaks on the south and east slopes of Cahto Peak (T21N, R15W, Sec 7, MDM) are extensively gullied, indicating that severe erosion has occurred. Apparently the lack of sufficient water diversionary structures has provided the means by which runoff can concentrate. The area of the burn contained by the firebreak also shows evidence of substantial gullying. A number of conditons which are associated with wildfire situations could be causative in the development of the burn area erosion gullies. The south slopes of Cahto Peak are drained by Kenny Creek and Mud Creek; and east slope by Mill Creek which flows east towards Laytonville. All of the streams are perennial tributaries to the Eel River.

Effects on Beneficial Uses: Even though the Eel River drainage is known to discharge extremely vast amounts of sediment, it supports one of the best runs of steelhead and salmon in the state. This fishery, along with several state parks and campgrounds, has made the Eel River popular for various recreational uses.

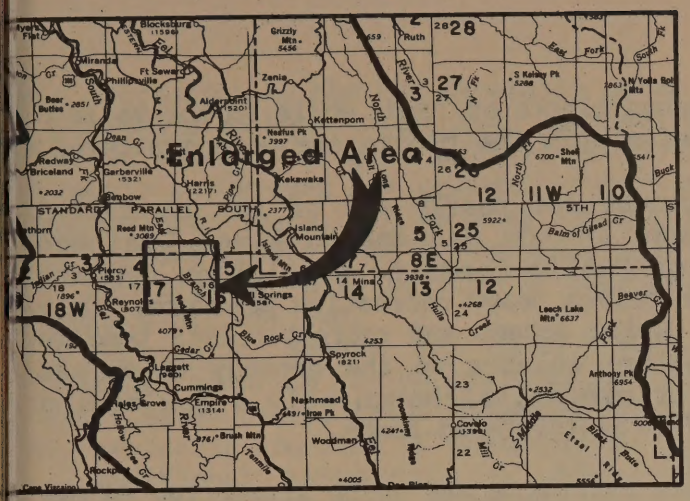
Due to the extremely high background sediment loads in the Eel River the actual impacts of the eroding firebreaks are not known.

Information Needs: A site review of the burn area and firebreaks in the area should be conducted by a hydrologist to determine the extent to which the firebreaks have stabilized. A field review during the spring runoff peak period would also be desirable to observe the level of sediment delivery to the three streams involved.

Sacramento River Drainage Hydrologic Area

The northwest half of the Clear Lake Resource Management Area drains into the Sacramento River; as does a very small portion of the Mendocino Resource Managment Area. The East Lake Planning Unit and Cow Mountain

Eel River Hydrologic Area



U.S. Bureau of Land Management
UKIAH DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

ELKHORN RIDGE (NORTH), TOM LONG CREEK, & RED MOUNTAIN

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)

R. 4 E. R. 5 E.

HUMBOLDT CO
MENDOCINO CO

Tom Long Creek Silviculture

Red Mountain Silviculture

Elkhorn Ridge (North) Low Volume Roads

BM 2437

LINSER MINE

Noble Butte

South Fork Eel River

Creek ROAD

Drewry

RED MOUNTAIN

T. 5 S. Humboldt Base and Meridian

T. 24 N. Mt. Diablo Base and Meridian

R. 17 W. R. 16 W.

1 Inch = 1 Mile

Figure 3-62

Planning Unit contain fairly contiguous blocks of land; while in the Vallejo Planning Unit and Putah Creek Planning Unit the blocks are more scattered.

Two major features of the area account for nearly all of the identified problems on BLM administered lands in the Sacramento River Drainage Hydrologic Area. The proximity of Public Lands to population centers creates a situation where the area receives heavy recreation pressure. Only a few tracts of public lands have public access and recreationists tend to congregrate there. The second feature relates to the geology which has attracted a considerable amount of mining, although only a few mining associated problems are located on BLM administered lands.

The lands between Clear Lake and Lake Berryessa are quite attractive to ORV users. Motorcycles and four wheel drive vehicle damage has been reported to be creating erosion problems in some areas. Waste disposal problems at camping areas have been associated with concentrated recreational use.

In the Clear Lake Resource Management Area, 2431 AUM's of livestock grazing are supported on BLM administered lands. No major problems are known to be associated with the grazing activity. Contamination of spring sources tends to be a universal problem in areas of livestock usage. Water from springs and streams are sources for livestock water supply.

Silvicultural activities are minimal in the area. Since most of the timber is of marginal commercial size and quality, salvage operations are the only activities anticipated.

Major water bodies in the Hydrologic Area include Clear Lake and its tributaries and Scotts Creek which flows in from the west. Clear Lake is the largest natural freshwater lake totally within California. It has been reported that the lake is prematurely eutrophic. This eutrophication has been partially explained by natural, as well as culturally induced processes. While the BLM does not administer land adjoining the lake it does manage land on the tributaries.

Essentially, at its present level, Lake Berryessa does not have any BLM administered shoreline. However, portions of lands along Putah Creek and Pope Creek drainage systems are managed by the BLM.

Recreation

Cache Creek (Existing)

Public Lands provide substantial opportunity for recreational activities in the Lake Berryessa - Clear Lake area. To help accomodate part of the visitor pressure, the BLM allows camping on lands under their administration and, in some locales, provides camping facilities. Undeveloped camping in T13N, R5W, Sec. 35, MDM, is reported to be causing bacterial pollution of nearby Cache Creek. Increasing visitor use trends and indiscriminate waste disposal practices by visitors have resulted in environmental pressures which exceed the design capacity of the campground.

Cache Creek which drains the hills northeast of Clear Lake is a perennial tributary to the Sacramento River. The lands administered

for recreation by the BLM generally occur in the upper half of the drainage.

Effects on Beneficial Uses: Several dwellings and small communities are located along the lower half of Cache Creek. It is doubtful that these domestic water uses are presently being contaminated by pollutants from BLM administered lands. Of greater concern would be contamination of drinking and contact waters used by recreationists on Public Lands.

The drainage also provides a cold water fisheries. The impacts on this resource are unknown.

Information Needs: A review of existing water quality data along with "bracket" sampling of the visitor use areas, as well as sampling where Cache Creek leaves public lands would be necessary in order to identify impacts to the resources and uses of Cache Creek.

Additional information on water quality associated with visitor use contamination is needed in other areas of the Sacramento Valley Hydrologic Area. Four sites have been identified where contamination is suspected and should be investigated further. They are Winton Campground (T15N, R6W, Sec. 26, MDM.), Pocock Creek (T11N, R5W, Sec. 26, MDM.); Barrel Spring (T15N, R6W, Sec 13, MDM.); Hunting Creek (T11N, R5W, Sec. 12, MDM).

Hunting Creek (Existing)

Hunting Creek headwater channels drain the east slopes of Grizzly Peak then flow generally to the south entering public lands in T12N, R5W, Sec. 28, MDM. The stream continues south, through private and public lands for another 12 miles (19 km) where it joins Putah Creek which discharges into Lake Berryessa. Due to a combination of desirable terrain and convenient location (between Lake Berryessa and Clear Lake), BLM administered lands along Hunting Creek are popular sites for motorcycle and other ORV use. As a result, Hunting Creek now has numerous undesigned fords. Sediments generated from compacted soils, denuded and destroyed banks, and disturbed streambeds are being carried downstream.

Effects on Beneficial Uses: Leasure time recreational activities in this area would be affected by increased low-flow turbidity levels and overly exposed stream banks. Increased sedimentation would also lower the potential of the fisheries habitat.

Information Needs: A stream inventory will be necessary in order to provide recommendations for stream crossings designed for sediment control. A monitoring program bracketing activity areas could provide needed information regarding the significance of any realized impacts to downstream resources.

Jericho Creek (Existing)

Public lands in the Round Mountain-Jericho Valley Area (T11N, R5W, MDM.), provide an opportunity for off-road vehicle recreationists to enjoy their activity. However, increased visitor numbers and indiscriminate use by some enthusiasts has led to the loss of protective vegetative cover on steep slopes with fragile soils. Consequently, the soils are eroding. The gullies which have formed indicate that sediments are being delivered to Jericho and Hole Creeks during the winter runoff season.

Both of these streams are perennial in nature and join in the center of the O.R.V. activity area. Jericho Creek then connects with Hunting Creek and flows into Lake Berryessa.

The Walker Ridge area (T15N, R6W, MDM) is reported as having the same types of problems. Sediments are being delivered to the Indian Valley Reservoir and to the tributaries of Cache Creek, previously described.

Effects on Beneficial Uses: The streams are primarily used for contact and noncontact recreational purposes. The effect on fisheries habitat and aesthetic quality are of the greatest concern. Hydrologic qualities can also be altered by increased runoff, which could effect the watershed values.

Information Needs: Accurate assessments of levels of sediment delivered to the channels in both areas are needed in order to understand the magnitude of the problem, where contributions are most significant, and what the impacts are.

Mining

Davis Creek (Existing)

Several mines in the Knoxville area were reported by the North Coast Water Quality Control Board and by district personnel as creating problems. However, none of these mines are on lands administered by the BLM. The Cinnabar Mines in the Davis Creek area (T12N, R5W, MDM) are the only ones which were reported to be affecting the waters which flow through these public lands. At times Davis Creek apparently turns a copper color with a floating skum. This condition is thought to be associated with the operations in the vicinity of the Reid Mine and the Harrison Mine.

Effect On Beneficial Uses: Visual, recreational and fisheries resources of Davis and Cache Creeks would undoubtably be effected. However, actual levels and nature of the pollutants are unknown.

Information Needs: The BLM has no authority associated with pollution by mining activities on private lands; therfore, no additional information is needed by the BLM. Additional information on the source, cause, nature, and quantity of pollutants should be gathered before other agencies take any action on this problem.

Fire

Langs Peak (Existing)

Langs Peak, located in Sec. 7, T12N, R4W, MDM., drains to the north and east into Cache Creek and to the west and south into Davis Creek. In 1976 a wildfire burned several sections of public land in the area. The steep disected slopes leading down to the streams currently show evidence of accelerated erosion where new gullies have formed. Apparently much of the area which was burned is still devoid of vegetation needed to protect the soil from rainfall impact. Fire trails may also be contributing to the problem.

Effects on Beneficial Uses: The Cache Creek drainage is popular for various recreational uses as previously described. Hunting will undoubtably apply additional visitor activity to the burn area. Fisheries and down stream water supply, as well as watershed values, are all important water quality considerations in this drainage.

Information Needs: A watershed analysis of the burn would indicate the current rate of revegetation and indicate specific problem sites which would

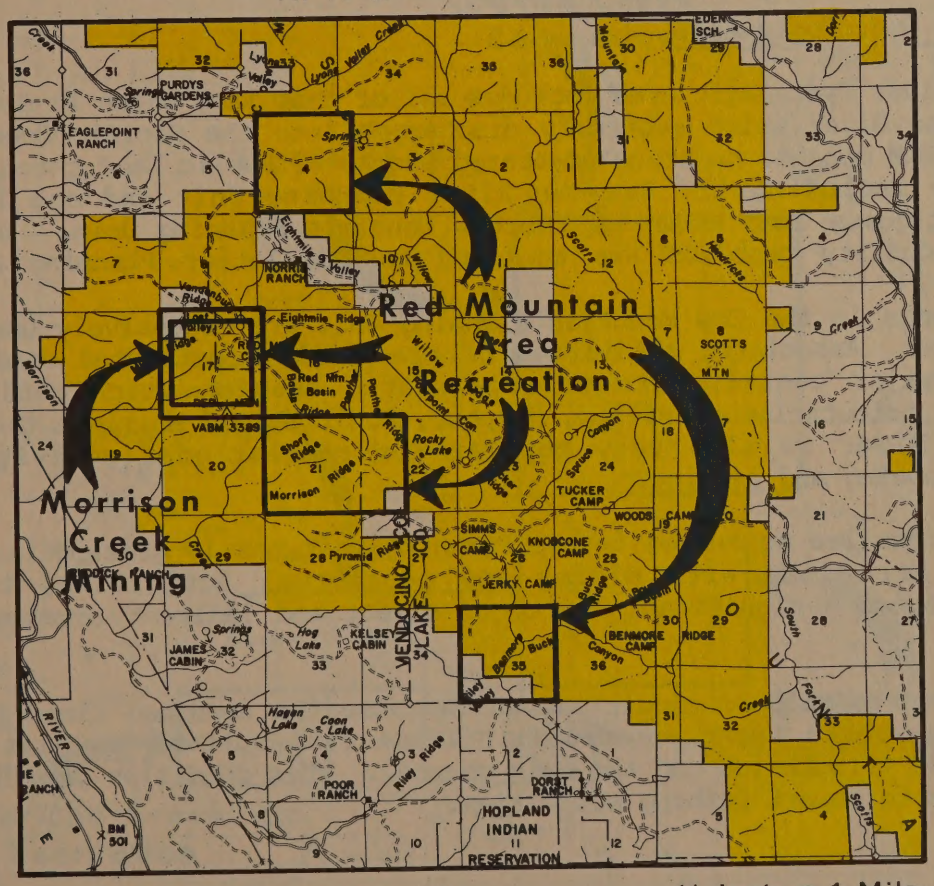
Russian River Hydrologic Area

U.S. Bureau of Land Management
UKIAH DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

RED MOUNTAIN AREA & MORRISON CREEK

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)



Mt. Diablo Base and Meridian

½ Inch = 1 Mile

Figure 3-63

would need additional treatment. Gully transects would indicate the rate of sediment delivery to the stream system. Additional information is needed in order to project background levels of sediment in the drainage. Water quality sampling should be conducted to determine the magnitude of impact on beneficial uses.

Cow Mountain Area (Suspected)

The use of fire as a management tool has been quite effective in many cases and should be considered a viable tool. However, under certain circumstances the removal of vegetative cover on some soils has been associated with increased soil detachment by raindrop impact and increased overland storm runoff. The process by which this occurs can be very complex and the indicators of accelerated erosion may be deceptive.

The area of the Cow Mountain Burn was reported as exhibiting indications of increased erosion. The 8 & 4 Mile Glade areas in T14N, R11W, MDM, are thought to be particularly effected.

Effects On Beneficial Uses: If there is increased erosion, sediment delivery to tributaries of the Scotts Creek drainage could be impacted. In turn, increased sediment would effect the recreational and fisheries uses of these drainages.

Information Needs: The area should be reviewed by a hydrologist and a soil scientist to verify causative conditions and to determine the significance of impacts to other uses. Since this area was burned to increase water yield, existing data for water yield (wells) should be evaluated.

Russian River Hydrologic Area

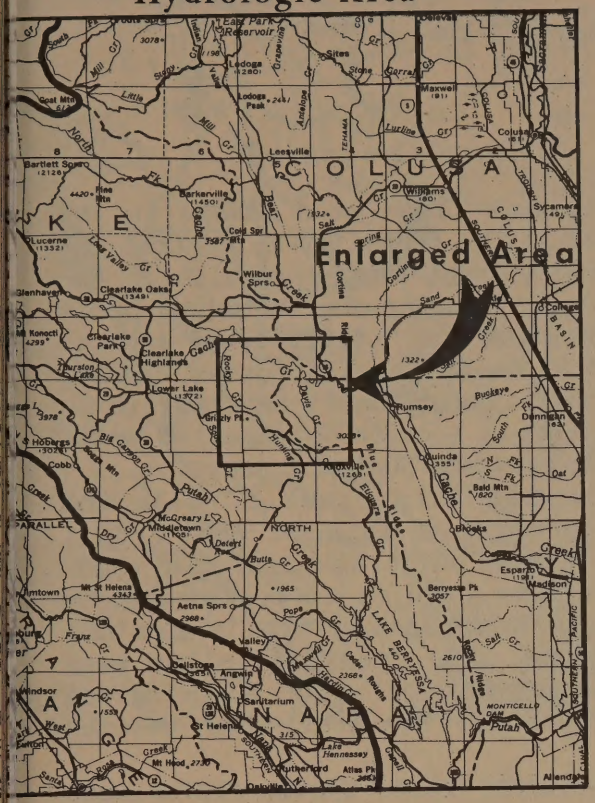
The Russian River Hydrologic Area includes all of that land which is drained by the Russian River which eventualy discharges into the Pacific Ocean at Jenner. The BLM manages numerous scattered blocks of Public Land throughout the drainage including the Russian River Planning Unit and one large tract of contiguous land known as the Cow Mountain Planning Unit. Identified water quality problems are confined to the latter Planning Unit.

The Public Lands in the Cow Mountian Planning Unit are extensively used by recreationists. Associated activities on previously constructed roads is one of the major contributors to accelerated erosion which could be affecting the tributaries of Willow, Sulphur, McClure, and Morrison Creeks. The Russian River is also very popular for recreational activities, especially canoeing and rafting.

Timber operations are conducted in the Planning Unit, as is grazing in both Planning Units. Along with mining and geothermal activities, these activities provide a significant source of direct and indirect revenue, to the area.

In spite of the hydrologic conditions which cause the seasonal flood flows typical of the North Coast, anadromous fishes find suitable habitat for spawning in the tributaries and the main channel. This condition provides a viable fishery for sport fishing activities.

Sacramento River Drainage
Hydrologic Area

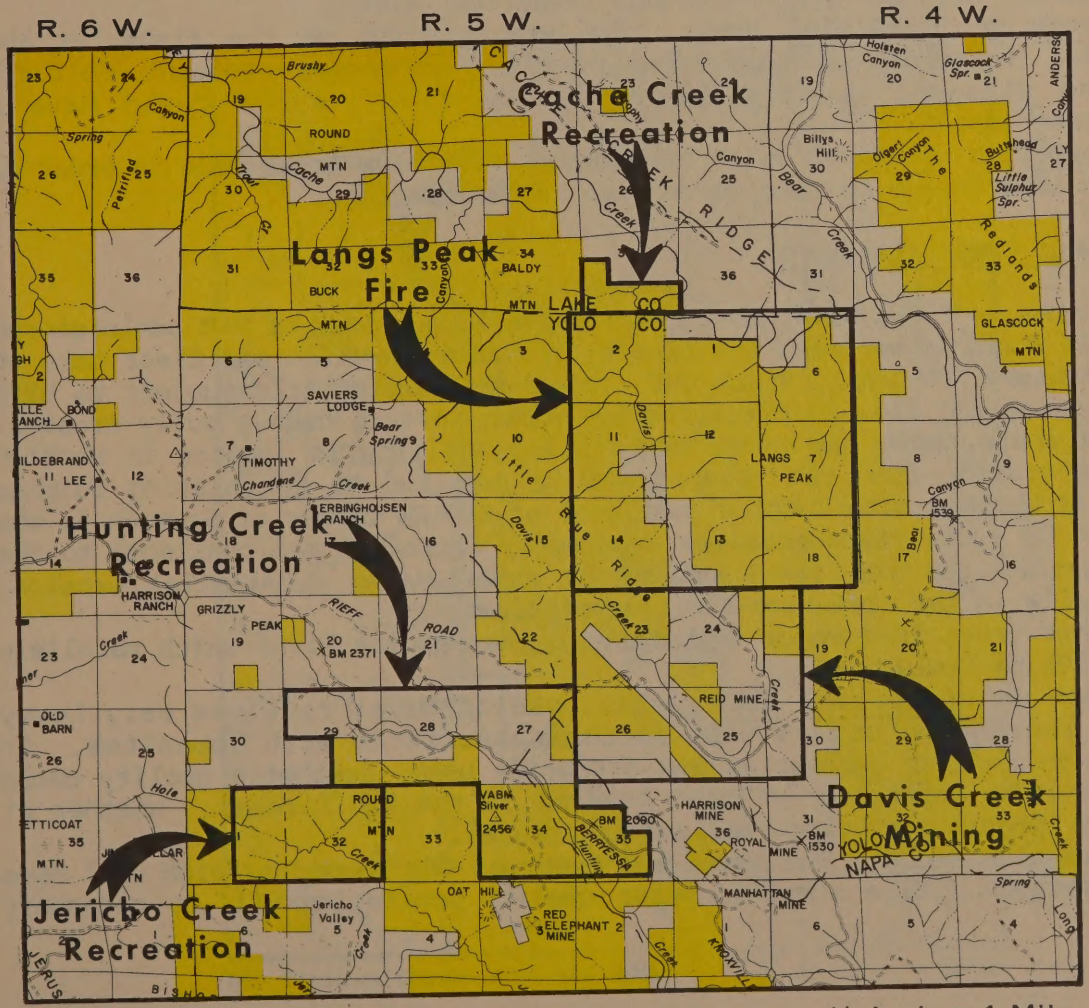


U.S. Bureau of Land Management
UKIAH DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

CACHE CREEK, LANGS PEAK, DAVIS CREEK, HUNTING CREEK, & JERICHO CREEK

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)



Mt. Diablo Base and Meridian

Figure 3-64

½ Inch = 1 Mile

Recreation

Red Mountain Area (Existing)

A situation similar to that for the Sulphur Creek area exists in the proximity of Red Mountain in T14N, R11W, MDM. The inability to control ORV operators who use Public Lands in an indiscriminant manner results in the degradation of the land and water resources. The Red Mountain area receives heavy recreational pressure and exhibits the diversity of impacts which can occur. For example, in section 35 an ORV trail crosses Binmore Creek without the benefit of a designed ford; in section 21 ORV traffic is reported to have damaged a natural spring; and in section 4 compacted soils have led to increased sediment delivery to Willow and Scotts Creeks.

Another common situation develops in old burn areas. Following wildfire, a number of fireline trails provide a type of ORV trail. Additionally, if the area requires timber salvage, skidtrails and spur roads are developed. Many of these roads are left open in order to provide access for rehabilitation activities. Since the suppression trails are not designed, due to the emergency situation, they are often not in the best location from the stand point of water quality. In section 22, a spring was encountered in a constructed portion of a trail. The trail then becomes rutted in subsequent use.

The slopes of Red Mountain and the associated ridge system drains west into the Russian River system and east into the Scotts Creek system. Both drainages are high use recreation and fisheries areas.

Effects On Beneficial Uses: The exact effect on the fisheries and recreation resources are unknown; however, increased sediment delivery to these streams, especially during low flow periods could have a significant impact.

Information Needs: On site assessments will have to be made in order to describe impacts and to make corrective recommendations.

Sulphur Creek (Existing)

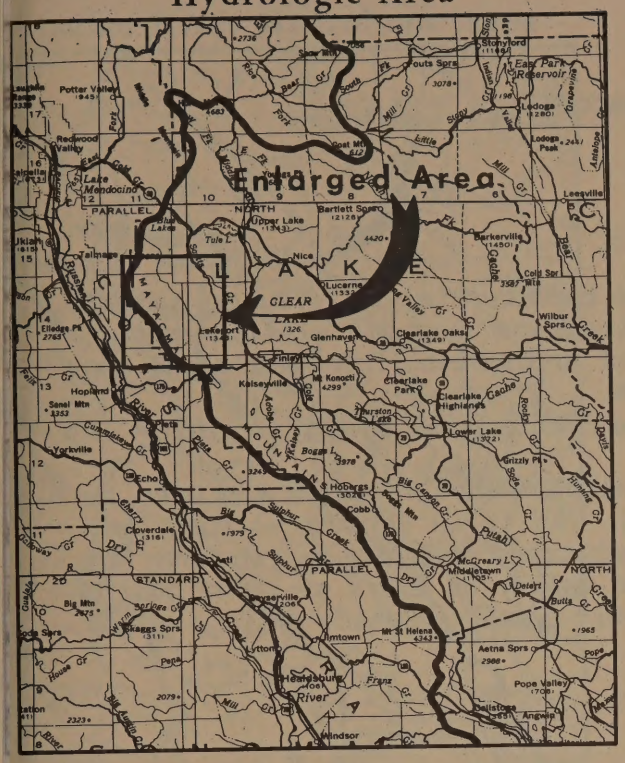
The area in T15N, R11W, MDM. comprises a large block of BLM administered land. As such, along with the area's proximity to Ukiah and Clear Lake it receives heavy ORV use. Steep ORV trails are particularly subject to high velocity overland flow of precipitation which in turn causes gully erosion. One site where there has been uncontrolled activity is located in section 12. The erosion from the steep trail is reported to be entering Sulphur Creek. At another site located just west of the SW corner of Section 4, the placement of restriction barriers apparently increased the challenge to the ORV operators and the trail beyond is experiencing substantial erosion. Other trails in the area have similiar problems.

Sulphur Creek is a major tributary to the Russian River which parallels Highway 101 to Healdsburg.

Effect On Beneficial Uses: The Russian River receives very heavy contact recreation use as well as uses associated with homesites. In addition to contact recreation and fisheries uses, aesthetic quality could be effected by increased sediment loading of the two streams. Whether or not these impacts are being realized is unknown.

Information Needs: The level and exent of ORV caused erosion will need to be assessed. Site specific water quality monitoring will be necessary

Sacramento River Drainage
Hydrologic Area



U.S. Bureau of Land Management
UKIAH DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

COW MOUNTAIN AREA

LEGEND

Suspected Problem Area

Patented Lands

Public Lands (BLM)

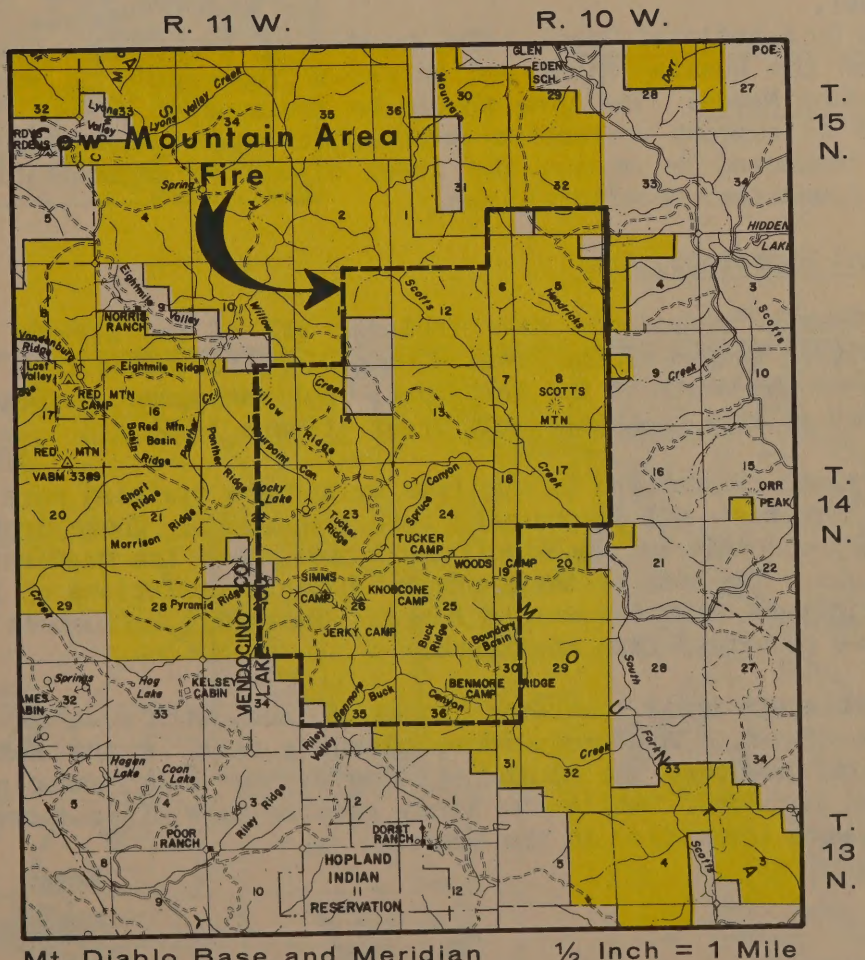


Figure 3-65

in order to determine the magnitude of impact.

Mining

Russian River and Putah Creek (Existing)

Sediment and chemicals were reported to be occurring in tributary waters of the Russian River and Putah Creek drainage system. Intrusions of sediment, mercury and boron are suspected of originating from geothermal and mineral mining activities in T11N, R8W, MDM.

Effects On Beneficial Uses: The actual effect of mining activity in this area is unknown.

Information Needs: The district hydrologist should review the area to determine if BLM lands are being affected. If it is determined that they are, water quality monitoring should be instituted in order to regulate BLM activities as necessary for the health and safety of users of those public lands. Outside regulatory agencies should verify the conditions cited before recommending any action.

Morrison Creek (Existing)

The Red Mountain Mine near the headwaters of Morrison Creek in T14N, R11W, Sec. 17, MDM, was reported as contributing mine runoff into Morrison Creek. Sediments and mine leachates could have a very significant impact on the downstream uses of Morrison Creek which discharges directly into the Russian River.

Effects On Beneficial Uses: The aesthetic, recreation, and fisheries resources of the Russian River and Morrison Creek would be most effected.

Information Needs: The mine should be reviewed to assess the specific impacts and to suggest corrective recommendations. Water quality sampling should be conducted to assess the level of stream contamination and the effects of downstream beneficial uses.

North Coastal Hydrologic Area

The North Coastal Hydrologic Area includes all of the streams which flow from the western slopes of the Coastal Mountains, extending from the Russian River north to the mouth of the Eel River. For management purposes the area has been divided into two hydrologic areas (figure 3-55).

The South Hydrologic Subarea is typified by streams draining more or less in a westerly direction and discharging into the ocean. These drainages have few tributary channels of any significance and have low gradients cut into soft sediments. The beds of these streams have accumulations of fines, much of which originate from the stream banks. The tidal influences may extend several miles up stream from the mouth.

The BLM administers small scattered blocks of land, with most occuring south of the Noyo River. The predominate planning unit is the Russian River Planning Unit; however, the southwest edge of the East Mendocino Planning Unit is also included. While the lands receive some minor recreation use, no problems were identified in the Subarea.

U.S. Bureau of Land Management
UKIAH DISTRICT
WATER QUALITY
PROBLEM ASSESSMENT

SULPHUR CREEK

Russian River Hydrologic Area

LEGEND

- Existing Problem Area
- Suspected Problem Area
- Patented Lands
- Public Lands (BLM)

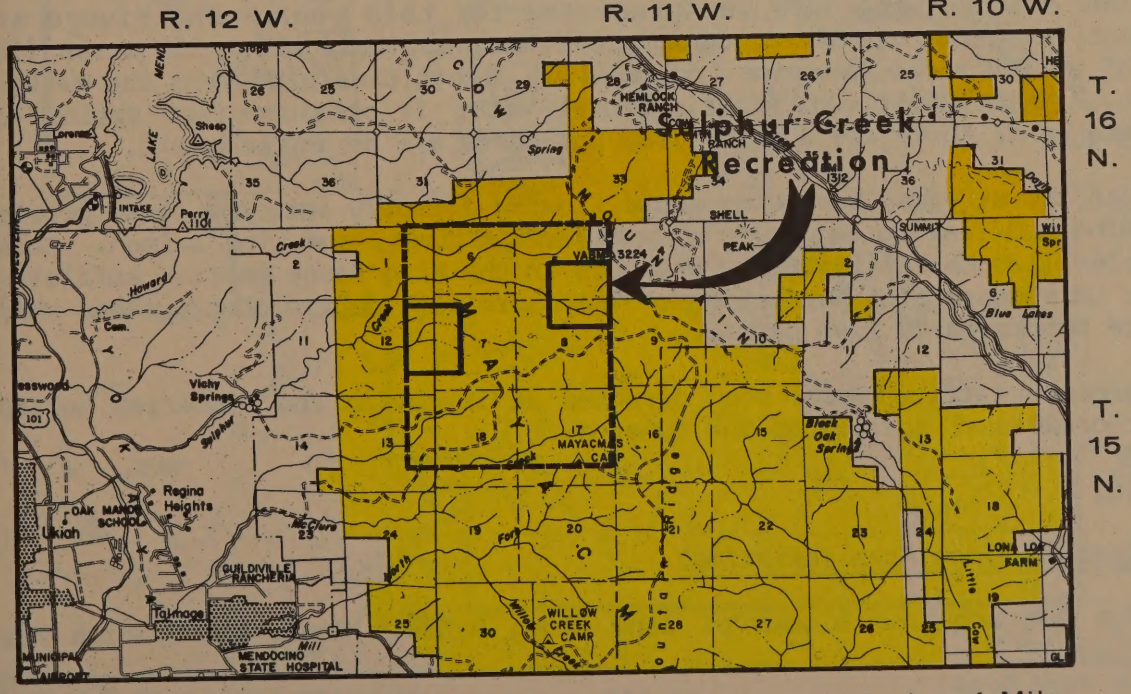


Figure 3-66

½ Inch = 1 Mile

To the north, the King Range Hydrologic Subarea includes those drainages originating in the King Range and draining either east or west; as well as, those minor drainages to the north and south which flow directly to the ocean. Bear River is also included in this Subarea. The King Range drainages, Bear River, and Mattole River tributaries have steeper gradients, coarser bed material and greater relief than those in the South Subarea.

While there is considerable variation in the hydrology from year to year, and from one location to the next, the average yield of runoff from the area is about 82 percent of the total precipitation which averages from 40 inches/year (102 cm) in the western lowlands to 110 inches/year (279 cm) in the mountains. Subsurface storm flow is thought to be the major conveyance of precipitation to the stream channels. The average runoff for the Mattole River watershed is gauged at 970,100 acre feet (1.2 billion M^3). Approximately 55,300 acres feet (68.2 billion M^3) of runoff drains from Bear River and 52,300 (64.5 million M^3) from the Honey Dew tributary of the Mattole.

Erosion and sedimentation are dominant processes in the area. It has been estimated that about 80 percent of the sediment load in the streams is a product of natural processes and that 90 percent of this occurs during 10 percent of the storms events. Logging, timber conversion, and road construction have been identified as the major contributors of man induced sediment.

The BLM administers three major tracts of land which are more or less contiguous blocks and several scattered blocks. Aside from the King Range National Conservation Area, which is managed as a Planning Unit, the larger tracts are a part of the Humboldt Planning Unit, and the scattered blocks are managed as a part of the Mad River Planning Unit.

The coastal streams are primarily used by fish, wildlife and livestock for habitat or dinking water. While recreation has a good potential for secluded activity only 56,000 visitor use days were reported in 1973; over 100,000 visitor use days was predicted for this year. The rivers are subject to almost no direct consumptive use, and only about 350 acres (142 ha) of agricultural land are irrigated by direct diversion from the Mattole river. Most domestic and agricultural water is obtained from springs on private land; there are a few wells, but there are no impoundments.

Many of the streams, including those flowing directly into the ocean provide spawning and rearing habitat for steelhead, silver, and king salmon. About 80 miles (128 km) of tributary channels in the King Range contain sufficient water to support fish populations. There are some debris obstructions which create blockages to fish passage.

Management practices have been directed at improving the fisheries habitat and recreational quality of the Subarea.

Grazing

Spanish Ridge Area (Existing)

The BLM acquired blocks of land along Randall Creek and Spanish Flat

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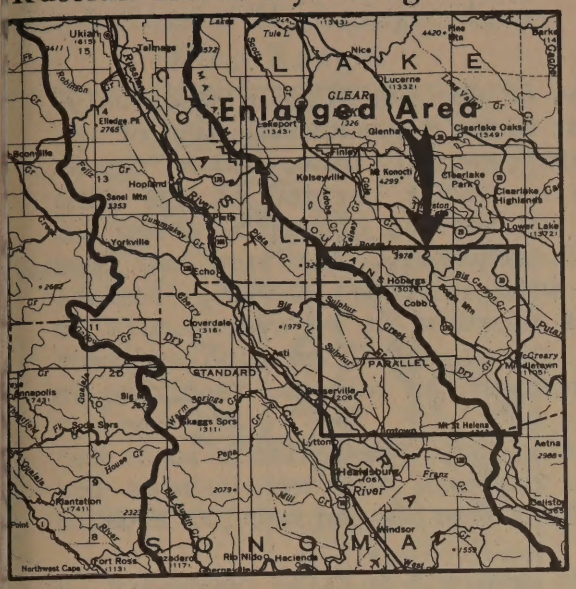
WATER QUALITY
PROBLEM ASSESSMENT

RUSSIAN RIVER & PUTAH CREEK

Russian River Hydrologic Area



LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)

R. 9 W. R. 8 W. R. 7 W.

T. 12 N.

T. 11 N.

T. 10 N.

Russian River and Putah Creek Mining

Mt. Diablo Base and Meridian

Figure 3-67

4/10 Inch = 1 Mile

Creek which drain the north and south slopes of Spanish Ridge respectively. These lands are included as part of the west slope recreational zone of the King Range National Conservation Area and are generally described as the NE portion of T3S, R22W, HM; located in the northwest portion of the King Range. Prior to BLM acquisition the area was heavily grazed by sheep and the Randall Creek drainage was burned. Subsequently, the area has been observed to be in a deteriorated condition with extensive ongoing erosion. By way of example, one very deep gully was measured to be over a mile in length. Conditions such as these subject runoff waters to high sediment loads, both in transit and stored in the streambed, as well as, resulting in increased thermal loads.

Effects on Beneficial Uses: Severe erosion and high sediment loads can substantially alter the natural hydrologic regime. The consequences for such alterations can significantly affect the fisheries and natural aquatic resources.

Information Needs: A detailed watershed analysis will be necessary in order to prescribe mitigative measures which will be necessary to rehabilitate the streams. Monitoring of the physical and biologic features of the stream would be advisable to determine recovery rates and trends.

Recreation

Big Flat Creek (Existing)

Dune buggy use on the Public Lands located in T4S, R1W, Sec. 10, HM, has resulted in a substantial reduction in the vegetative cover which protected the site from erosion. Since sheep have grazed the site in the past, the use of dune buggies in the area is somewhat more impacting than in other areas. With the reduction in vegetation and increase in soil compaction, storm runoff is apparently carrying sediments to Big Flat Creek.

After leaving Public Lands Big Flat Creek flows approximately a mile to the ocean. The BLM administers the remaining 2 miles (3.2 km) of stream channel.

Several of the coastal drainages in the King Range are of similar size and accessability and it is suspected that they may also be in the same condition.

Effects on Beneficial Uses: No major uses are known to occur in the drainage. Fish, aesthetics, and watershed values are the beneficial resources present. The ocean, with its contained values is a receiver of the streams discharge. The actual impacts, if any, are unknown.

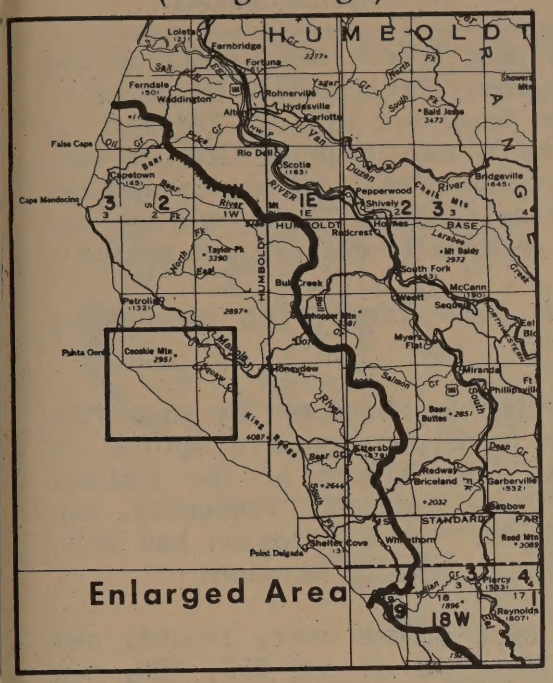
Information Needs: Stream highflow sampling of sediment would provide information regarding the present level of impacts. Sampling sites would need to bracket the dune buggy area, as well as a station at the mouth. A reconniassance of other coastal streams would be useful to document other areas with similar problems. Such observation would also indicate background conditions on a companion watershed basis.

Silviculture

King Range Acquired Lands (Existing)

With the acquisition of private lands in the King Range in order to establish the King Range Natural area, the BLM also acquired erosion and

North Coastal Hydrologic Area
(King Range)



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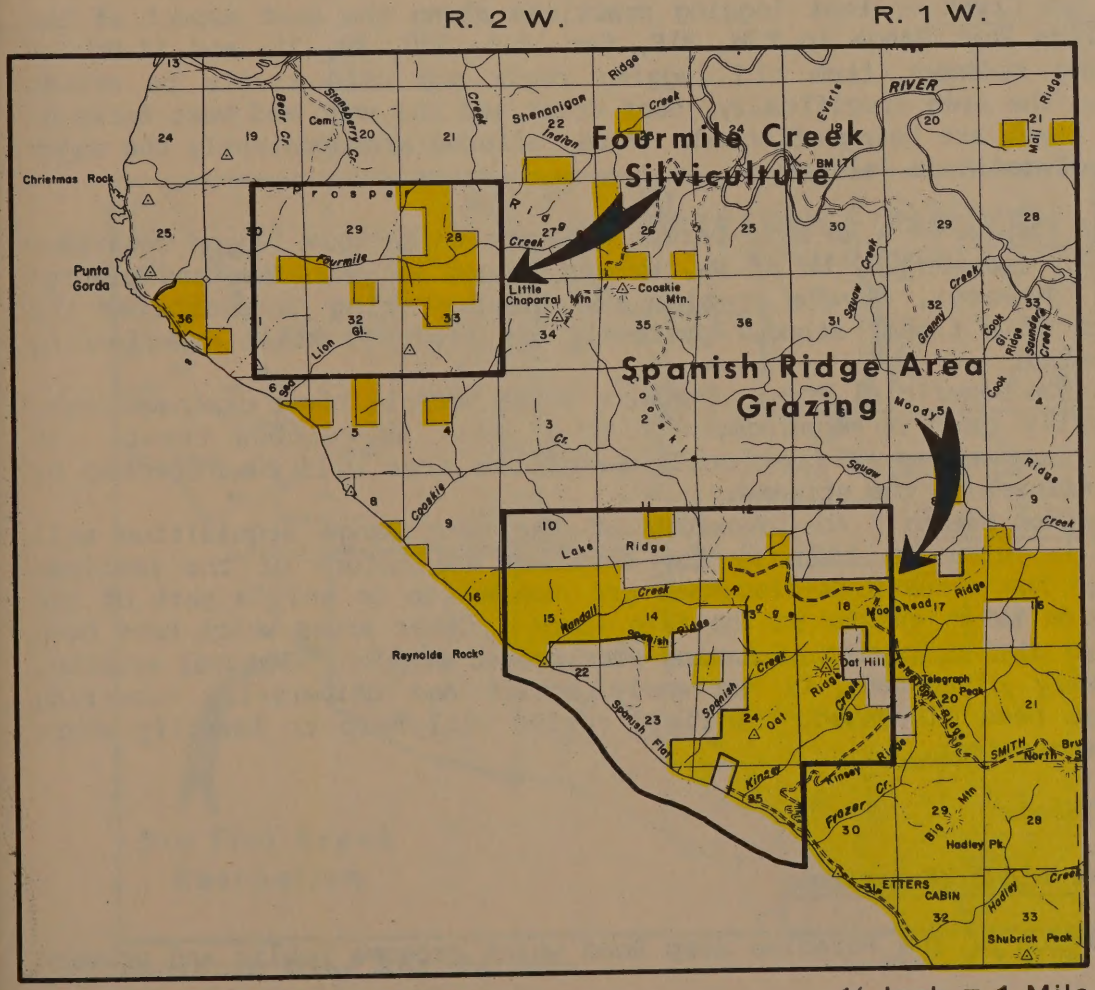
PROBLEM ASSESSMENT

SPANISH RIDGE AREA & FOURMILE CREEK

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)



Humboldt Base and Meridian

½ Inch = 1 Mile

Figure 3-68

sediment problems from earlier silvicultural practices. Nearly all of the acquired private lands have been logged while very little public lands have. The private lands were harvested prior to the inactment of 1972 legislation establishing the Forest Practices Rule. As a result prior logging and associated road construction methods were less than what is now considered acceptable. The conversion of timber to grasslands for livestock use was also popular in the area. This practice has reportedly contributed sediment to the streams.

Several specific acquired sites have been identified as having significant problems.

Four Mile Creek -- Two tracts of lands which are bisected by Four Mile Creek in T2S, R2w, Sec. 28,29, and 30 HM have undergone a series of disturbances. Fifteen years ago a wildfire burned much of the timber. Subsequently, the timber was removed and the area planted. Presently, the land adjacent to the creek is grazed by sheep. Sheet erosion has been reported on south aspects and roads are subject to ongoing erosion.

Nooning Creek -- Another area which had been burned over, logged, and roaded is along Nooning Creek in T5S, R1E, Sec. 1 & 2; and T5S, R2E, Sec 13 and 6 HM. In 1973, 4,000 acres along Finnley Creek, Bear Creek as well as Nooning Creek. Culvert discharges have been observed as having high sediment loads.

Honey Dew Creek -- Past logging practices along the east aspect of the portion Kings Peak Range in T2W, R1E, Sec. 4.5, 235, 30, 31, and 32 Hm are contributing sediment from old logging roads and skid trails to stream channels in the area specifically, Bear Creek and the east and west forks of Honey Dew Creek are being effected. Mass failures are apparently the major mechanism of sediment delivery.

Mattole Canyon -- A 40 acre parcel adjacent to Mattole Canyon described as T3S, R2E, Section 28, NW of NW, Hm was logged 15 years ago and planted to trees. However, severe erosion and sheep grazing has hampered the development of a timber stand. Apparently the tract is still experiencing severe erosion.

Effects On Beneficial Uses: The King Range Mattole River drainage areas are primarily used by anadromous fish as well as rainbow trout. In addition, increasing recreational use of the area will be effected by sediment influxes to the streams.

Information Needs: An inventory of the King Range acquisition will be needed in order to identify the severity and nature of the problems discussed. The situations discussed are assumed to be only a part of the total problem which exists in the King Range. Other areas which have been acquired are also suspected of having accelerated erosion. Natural erosion, as previously discussed, is extremely active and universally occurring and has not been discussed. A field review will help to identify where impacts are greatest.

Low Volume Roads

Paradise Ridge (Existing)

The portion of the Paradise Jeep Road which crosses public and private

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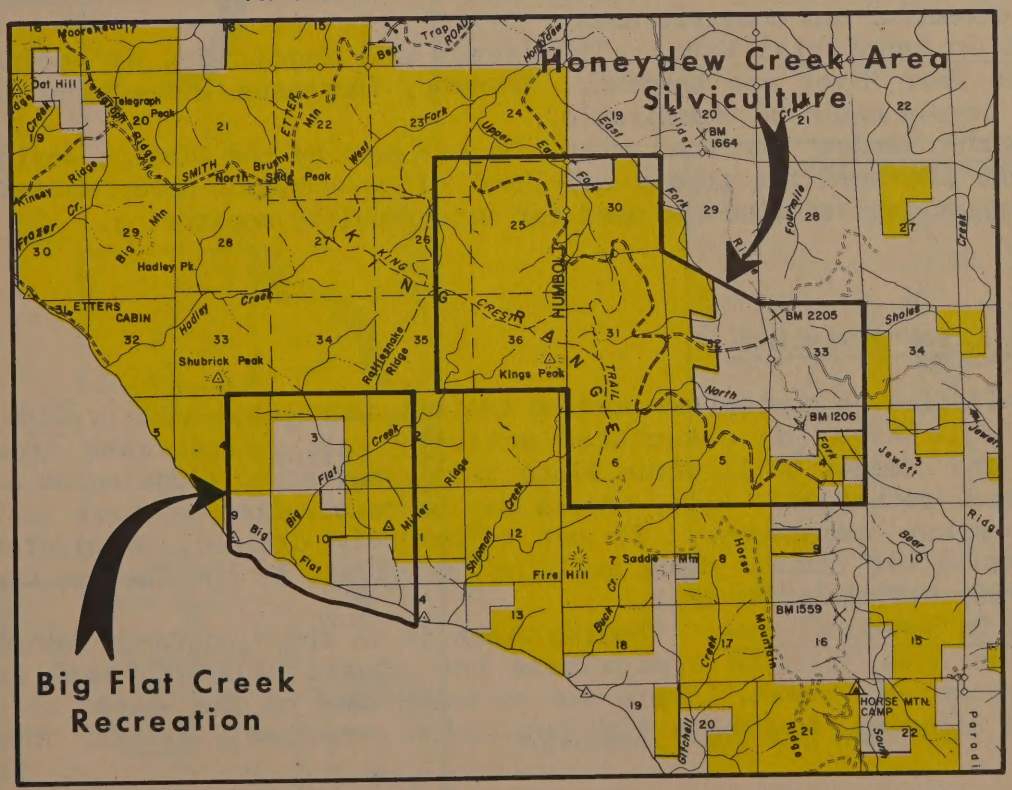
WATER QUALITY PROBLEM ASSESSMENT

BIG FLAT CREEK & HONEYDEW CREEK

North Coastal Hydrologic Area
(King Range)

LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)



Humboldt Base and Meridian

½ Inch = 1 Mile

Figure 3-69

lands in T4S, R1E, Sec. 23 and 26, HM, has had most of the drainage features obliterated by wet season use. This situation has led to uncontrolled runoff from the road surface and consequently severe gullying of the road surface, fill, and downhill slopes. Road surface generated water does not have the opportunity to infiltrate into the soil below the road due to the lack of vegetation and compacted soil condition. The down slope condition is reported to be due to overgrazing by sheep.

The sediments entrained by storm runoff are being discharged into the South Fork of Bear Creek, a major tributary to the Mattole River. Both streams support populations of cold water game fish.

Effects on Beneficial Uses: The actual effects of increased sediment levels on these streams has not been documented, but as is the case for other North Coast streams there can be substantial damage to fisheries habitat. As visitor use increases in the future, degradation of the aesthetic quality of the water may become a concern.

Information Needs: A documented road reconnaissance is needed to identify the specific drainage needs of the road. Water quality monitoring of the South Fork of Bear Creek would help to indicate the effects of rehabilitative measures.

Antone Creek (Existing)

In 1956, 275 acres (111 ha) of timber were partially cut. The haul road into the area identified as T1N, R1W, Sec. 31 & 32, HM., was abandoned following completion of harvesting. The features of the steep disected terrain in the headwaters of Antone Creek has led to the failure of much of the road. Recently a road right-of-way was granted for access to private lands. This reopening of the road may have reactivated some old failures. Sediment delivery to Bear River via the channel of Antone Creek has been reported. Bear River supports important anadromous fisheries, as well as, recreation and domestic uses.

Effect On Beneficial Uses: The levels and magnitudes of sediment delivery to Bear River are unknown. However, increases in sediment over background levels would be undesirable.

Information Needs: The road should be reviewed by the Distict engineer to determine the need for repair and level of maintenance required and by the hydrologist to determine the need for water quality monitoring.

Fire

Chemise Creek (Existing)

While wildfire or controlled burning was not identified as a problem in the Hydrologic Area, an associated activity was. Firebreaks remove vegetation and compact soil, often along ridges and steep ridge noses as a presuppression technique. Also, trails may be constructed anywhere during fire suppression operations. If not effectively drained, considerable surface erosion can occur. Such gullying is evident in the Chemise Creek drainage (T5S, R1E, Sec. 24, HM.).

Effects On Benefical Uses: Chemise Creek is in the King Range National Conservation Area with an approximate one square mile drainage area discharging into the ocean. There are no known uses of the waters of the creek being effected, however a fish population undoubtedly exists. Since

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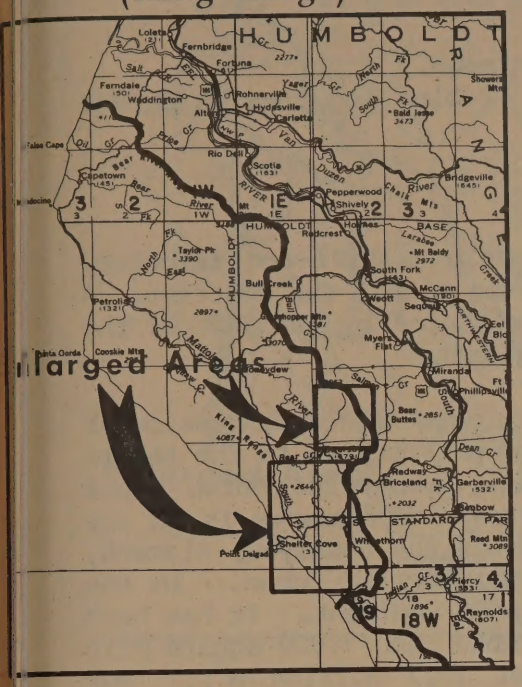
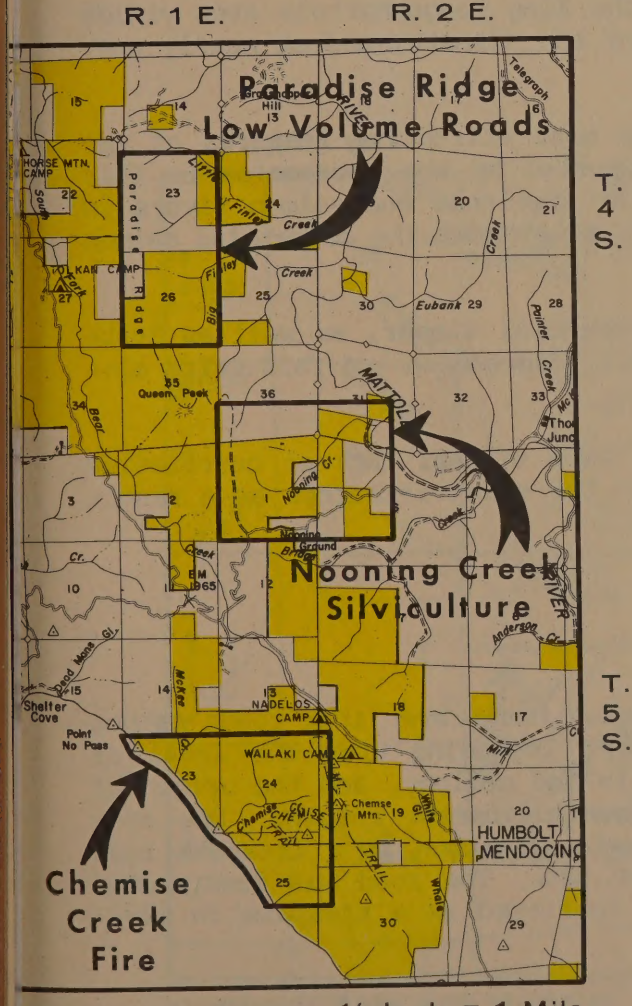
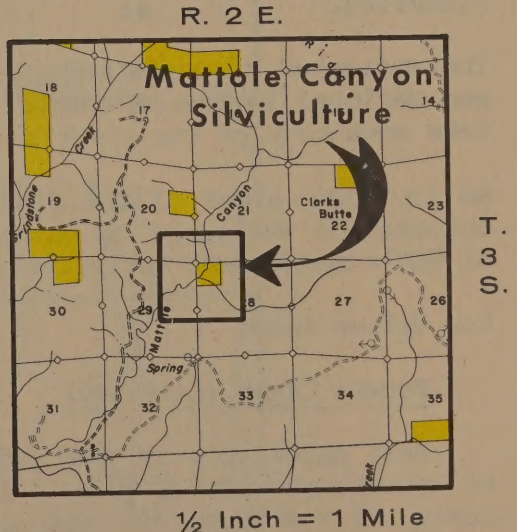
PARADISE RIDGE, NOONING CREEK, CHEMISE CREEK, & MATTOLE CANYON



LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)





Humboldt Base and Meridian

Figure 3-70

the drainages are of limited size, impacts are unknown.

Information Needs: Both the extent of the problem and uses which are being effected need to be verified.

Klamath River Hydrologic Area

The Klamath River Hydrologic Area includes the main channel and tributary system of the Klamath and Trinity Rivers which occur within the district. A relatively few blocks of Public Lands are administered by the BLM in the Humboldt Planning Unit and the Mad River Planning Unit.

Since only one problem was identified in the Hydrologic Area a discussion of the drainage is limited to the features which lend perspective to the nature of the problem discussed. The Klamath is unique among the North Coast drainages, in that it drains an intermountain area. Its source is in the Cascade Range and flows westerly through portions of the Siskiyou, Klamath, and Coast Ranges; and eventually empties into the Pacific Ocean. In the process, it naturally entrains an enormous amount of sediment. It has been estimated that the annual sediment yield for the more than 7,000 square mile (18,000 km^2) watershed averages 3,020 acre feet (3.7 million M^3). For that portion of the watershed within the Ukiah District, 810 acre feet (1 million M^2) are discharged from the 772 square mile (2000 km^2) lower watershed. While this is the highest sediment delivery rate for the basin, it is noteworthy that more than 50 percent comes from stream banks. In comparison with other Hydrologic Areas, the King Range-Mattole area yields sediment at nearly three times the rate of the Klamath, and at nearly one-ninth the rate of the Eel River.

The run of anadromous fish is one of the most attractive features of the river. Much of the local economy is supported by the attraction to this resource, as it is one of the most popular steelhead and salmon rivers in the state. The fish populations also help to support the commercial salmon fisheries.

The watershed supports major stands of commercial timber, as well as State and National Parks. A commercial jet boat concession and raft trips also take advantage of the river's settting.

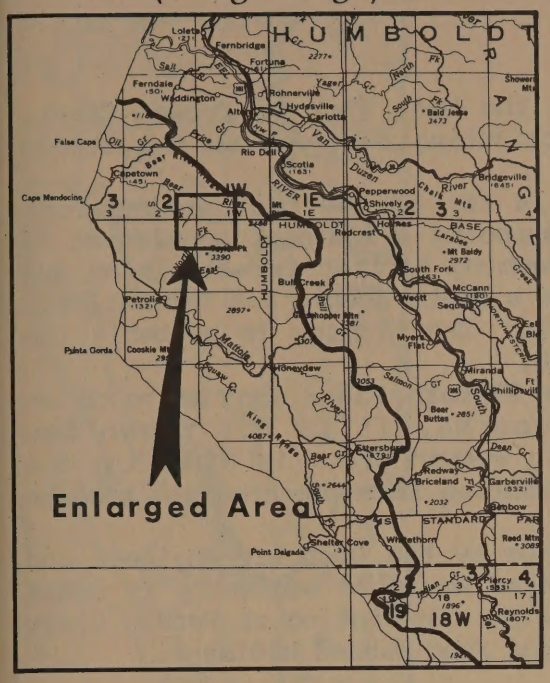
As in other areas of the district, there is a virtual lack of correlative information available to assess impacts on the river resources as a result of BLM's management activities.

Low Volume Roads

Pecwan Creek (Existing)

Past experience in the North Coast Region has proven that roads cannot be abandoned without proper winterization. Depending upon the level of design of the road, the nature of the soils and geology, and the origin of surface water runoff, winterization may mean different things. One area which may exhibit the consequence of non-winterization is a trespass road located in T11 1/2N, R3E, Sec. 33 and 34, HM. The road was constructed across BLM administered land in 1953 and confirmed as a trespass in 1960.

North Coastal Hydrologic Area
(King Range)



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PROBLEM ASSESSMENT

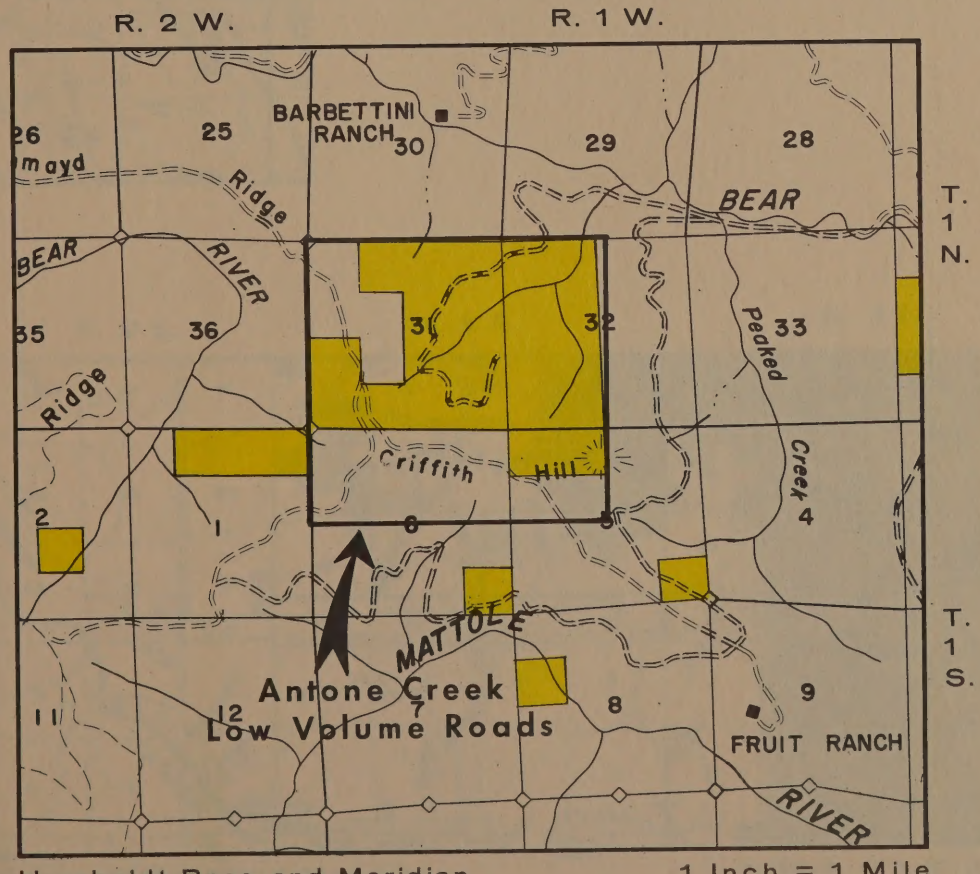
ANTONE CREEK

LEGEND

~ Existing Problem Area

Patented Lands

Public Lands (BLM)



Humboldt Base and Meridian

1 Inch = 1 Mile

Figure 3-71

The road is reported to be failing along the West Fork of Pecwan Creek. Surface erosion is also suspected of contributing sediment to the stream channel.

Pecwan Creek flows about 4 miles (6.4 km) to the southwest before joining the Klamath River. Pecwan Creek supports a resident population of cold water fish, and provides potential spawning habitat for steelhead and salmon. The Klamath River is classified as a State Scenic and Recreational River below the confluence of Pecwan Creek. The Klamath is probably the most popular fished river on the North Coast.

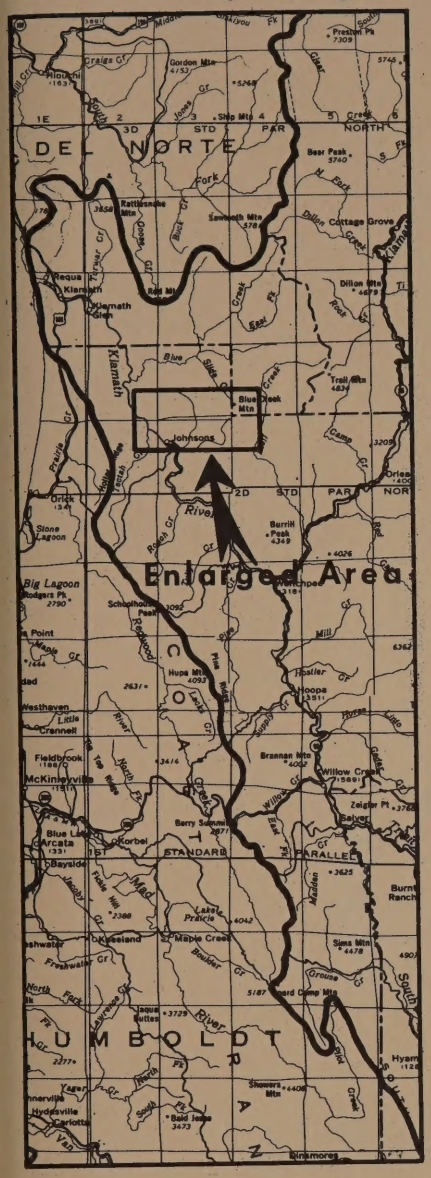
Effects On Beneficial Uses: Since the Klamath River carries such an enormous amount of sediment in its course, it is not known how significantly any accelerated erosion along Pecwan Creek is affecting the uses of the Klamath River; nor is the contribution from the trespass road to Pecwan Creek known.

Information Needs: A road reconnaissance by the District engineer and others familiar with slope stability processes would be necessary in order to recommend cost effective abatement measures. Monitoring of Pecwan Creek is needed to determine the significance of the road caused sediment.

Smith River, Mad River - Coastal
and North Bay Region Hydrologic Areas

The remaining Hydrologic Areas had no specific existing or suspected problems reported. The potential problems associated with road construction and timber harvesting which apply district wide apply to the northern areas. The North Bay Region Hydrologic Area has a limited amount of lands administered by the BLM and those are in scattered parcels. This area is partially addressed as being within the San Francisco Designated Area.

Klamath River Hydrologic Area



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WATER QUALITY
PROBLEM ASSESSMENT

PECWAN CREEK

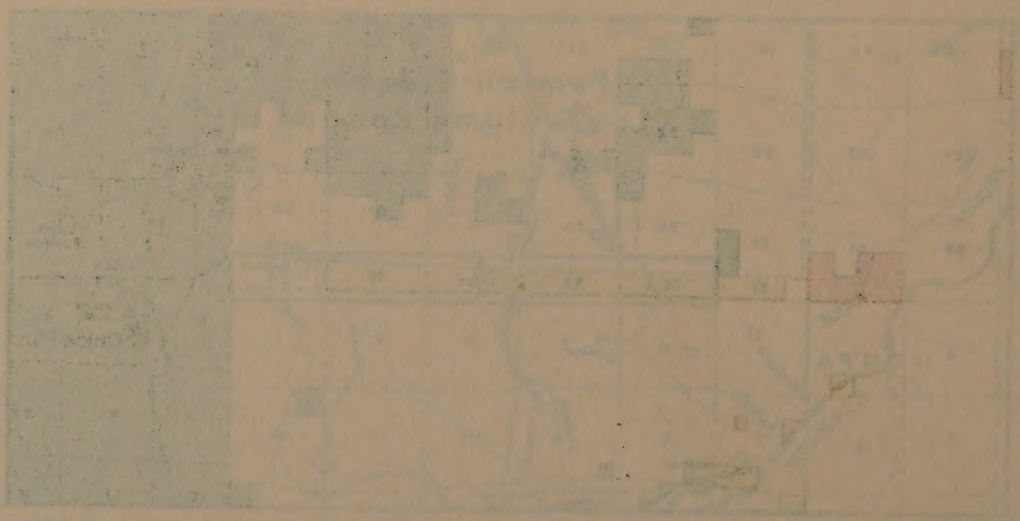
LEGEND

- Existing Problem Area
- Patented Lands
- Public Lands (BLM)
- National Forest Lands
- Indian Lands

Humboldt Base and Meridian

½ Inch = 1 Mile

Figure 3-72



PART II

BEST MANAGEMENT PRACTICES

INTRODUCTION

Part II of the Bureau of Land Management's 208 planning document primarily deals with the development of Best Management Practices and related subjects. These discussions fulfill the components of Standard Agreement #7-043-41 (California State Water Resources Control Board) not covered in Part I. The procedure which the BLM in California will use to insure compliance with the goals of the Clean Water Act1/ in accordance with Executive Order 12088 is described below. For the fulfillment of the contract only those activities associated with grazing and recreation are discussed; however, the methodology is meant to apply to all BLM management activities. "Best Management Practices" (BMP) means a practice or combination of practices determined by a State (or Area-wide Planning Agencies) after problem assessment, examination of alternative practices, and appropriate public participation to be the most effective, practicable (including technological, economic, and institutional considerations) means of preventing or reducing pollution generated by non-point sources to a level compatible with water quality standards.

Early in this BMP development effort it became evident that in order for any recommended management practices to satisfy the intent of the Clean Water Act they would have to be developed on a site specific basis. The lack of applicable information documenting the impacts of grazing and recreation management partially accounts for the impracticality of developing general BMPs to be applied throughout the State. Rather, a process has been developed which will assure that for each manageable site the best possible practices to meet water quality goals will be applied. This procedure will not only assure that Best Management Practices, in the truest sense of the term, will be applied throughout BLM lands in California but will also provide for the most meaningful consideration of economic, social, political and similar factors specific to each area. Further, this approach provides for 208 implementation in a fashion which is reasonably compatible with the current BLM planning process. Aside from providing the best practical approach for protecting water quality, the process encourages participation of all interested individuals and groups in a manner which will provide for the most meaningful incorporation of their insights and perspectives.

Part II describes the entire process which will be used, emphasinging the concept, the pollutants resulting from grazing and recreational activities and finally, recommendations to improve the current program. Each of the chapters will have a different level of meaning and importance to the various readers. BLM hydrologists will use the entire methodology as a working guide to the development of BMPs, while other readers may find that the summary sufficiently satisfies their concerns regarding the process.

Appendix A, discussing pollutants, will again be used by the BLM hydrologists as a guide to the best approach for assessing the level of impact of particular pollutants in an area of concern. Other readers may find the portion which discusses the processes by which pollutants are delivered to a water body most meaningful. Finally, the "Recommendations" section is intended for more general consideration.

1/ P.L. 95-217 is the Clean Water Act of 1977. P.L. 95-217 amends P.L. 92-500, the Federal Water Pollution Control Act of 1972.

The three phases of the BMP development process are described in Appendix C through the use of text and flow charts. The flow charts are composed of independent components (modules) each of which represents a particular function in the BMP development process. A static module (M) represents a function which is not expected to change in the future. A variable modulex (VM), on the other hand, represents a function which will be improved as experience and information are gained. The three phases of the development process are summarized in Figure 4-1.

SUMMARY FLOWCHART OF BMP DEVELOPMENT PROCESS

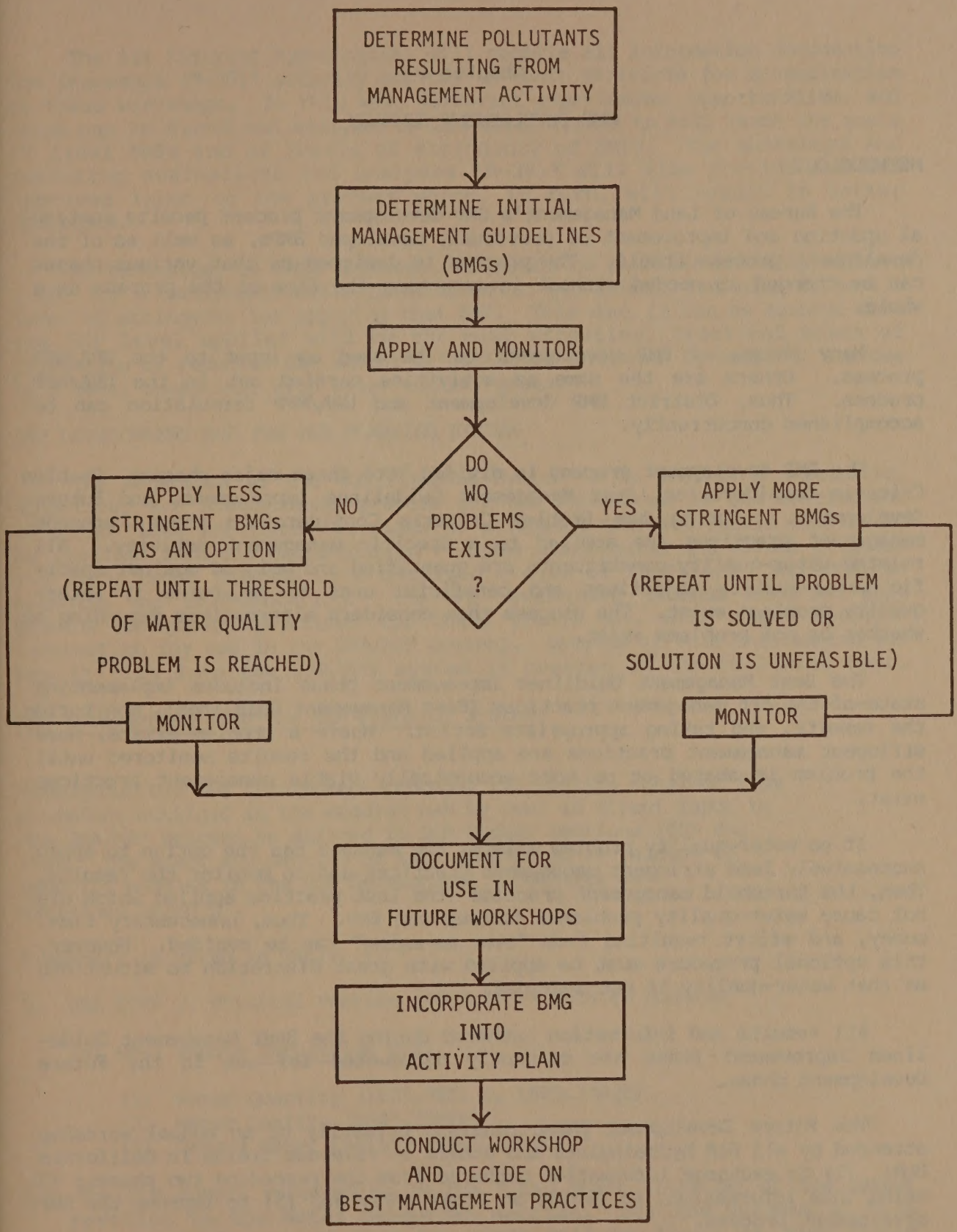

DETERMINE POLLUTANTS RESULTING FROM MANAGEMENT ACTIVITY
DETERMINE INITIAL MANAGEMENT GUIDELINES (BMGs)
APPLY AND MONITOR
DO WQ PROBLEMS EXIST ?
NO
YES
APPLY LESS STRINGENT BMGs AS AN OPTION
(REPEAT UNTIL THRESHOLD OF WATER QUALITY PROBLEM IS REACHED)
APPLY MORE STRINGENT BMGs
(REPEAT UNTIL PROBLEM IS SOLVED OR SOLUTION IS UNFEASIBLE)
MONITOR
MONITOR
DOCUMENT FOR USE IN FUTURE WORKSHOPS
INCORPORATE BMG INTO ACTIVITY PLAN
CONDUCT WORKSHOP AND DECIDE ON BEST MANAGEMENT PRACTICES

Figure 4-1

Chapter 4

BMP DEVELOPMENT SUMMARY

METHODOLOGY

The Bureau of Land Management's BMP development process permits continual updating and improvement of previously developed BMPs, as well as of the development process itself. The process is designed so that various phases can be changed as needed without interrupting the flow of the process as a whole.

Many phases of BMP development can be used as input to the URA/MFP process. Others are the same as activities carried out in the URA/MFP process. Thus, District BMP development and URA/MFP formulation can be accomplished concurrently.

The BMP development process is divided into three major phases: Problem Criteria Consideration, Best Management Guidelines Improvement, and Future Development. During the Problem Criteria Consideration phase, present management practices are applied to a specific management activity. All related water-quality constituents are quantified and weighed against specific water-quality objectives and beneficial uses to determine if water-quality problems exist. The process then considers alternatives depending on whether or not problems exist.

The Best Management Guidlines Improvement phase includes implementing state-of-the-art management practices (Best Management Guidlines), monitoring the results, and taking appropriate action. Where a problem exists, more stringent management practices are applied and the results monitored until the problem is abated or no more economically viable management practices exist.

If no water-quality problem exists, the manager has the option to apply successively less stringent management practices and to monitor the results. Then, the threshold management practice (the last practice applied which did not cause water-quality problems) becomes the BMP. Thus, unnecessary time, money, and effort resulting from "over managing" can be avoided. However, this optional procedure must be applied with great discretion to situations so that water-quality is not degraded.

All results and information gathered during the Best Management Guidelines Improvement phase are carefully documented for use in the Future Development phase.

The Future Development phase consists primarily of an annual workshop attended by all BLM hydrologists and others in relevant fields in California BLM: (1) to exchange information gathered from the preceding two phases; (2) using this information, to decide on final BMPs; and (3) to improve the BMP development process.

The workshops will be part of the California Water Management Plan as long as need exists.

The six District hydrologists will compile all information documenting the processes (M-26)* actually applied in their Districts for dissemination at these workshops. In this way, different experiences, opportunities, and needs can be shared and analyzed by all participants to help reach the goals of final BMPs and of levels of stringency of BMPs. The workshops and resulting evaluations and analyses (M-36)* will also provide new and improved input to the process which, in turn, will result in better decisions.

As technology on BMPs improves, it should be possible not only to have a BMP for a management activity or specific situations, but also to have a level of stringency for applying that BMP. This way, it can be assured that the BMP level applied will be the most effective, practical means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water-quality goals.

BMP DEVELOPMENT AND THE BLM PLANNING SYSTEM

The objective of the BLM Planning System is to provide a systematic, objective, and standardized process for use Bureauwide in the development of sound "Land Use Plans" or plans to allocated diccrete public land areas to specific land-use combinations. These plans guide and direct programs for such lands through more detailed stages of functional and program planning and implementation. The BMP development process will not only provide management practices for these plans, but, will supply specific information for use in the URA/MFP process. Details of this information and how it fits into the URA/MFP system is covered in the following text.

BMP Interaction with the BLM Planning System

Throughout the BMP development process, information obtained from procedure outlined in the modules can be used as direct input to the URA/MFP process as defined in BLM Manual Sections 1605 and 1608. The exact sub-section of each section as it relates to specific modules in the BMP Development Flowcharts is explained below 1/.

A summary is given in Table .

1. URA STEP 2, Physical Profile (1605.3) -- Related Modules

   (a) VM-1 inputs Tabulation for:

   (1) Water Quantity (1605.35A1 b, 1605.35A2b)
   (2) Water Quality (1605.35B1b)
   (3) Ground Water Quality (1605.35B2b)

1/ The BLM Manual referred to is the final draft (7-14-78). of the latest revision to the Water Resources section. For the purpose of this report, it is assumed that the draft will be final, or have little revision. A copy of the draft is included in Appendix .

* See Flowcharts Apppendix C

(b) Data and information acquired form the M-4 process can be used for most of the required tabulations called for in the BLM Manual.

(c) Narratives (1605.35A1c, 1605.35A2c, 1605.35B1c, 1605.35B2c) can be partly, or completely written from information acquired from all modules in the PCF.

2. URA Step 3 - Present Situation (1605.45A) -- Related Modules

(a) M-3 will input BLM Manual Section 1605.45A since it considers watershed response to past and proposed land uses and a cause/effect analysis of watershed problems.

(b) VM-1 will supply the following information to sections 1605.45A of the Manual: erosion conditions, hydrologic watershed characteristics, water availability, and water quality.

1/ The BLM Manual referred to is the final draft (7-14-78) of the latest revision to the Water Resources section. For the purpose of this report, it is assumed that the draft will be final, or have little revision. A copy of the draft is included in Appendix _____.

(c) VM-1 will provide all the necessary information for section 1605.45A7 (Water Quality). Any information pertaining to standards, criteria, and limitations of water quality to various uses will come from VM-2.

(d) VM-4 and M-36 will provide discussion for any BMPs that have been developed and/or adopted and which pertain to present or potential Bureau management activities as called for in Manual Section 1605.45A7.

3. URA Step 4, Watershed Management Opportunities (1605.45B)

(a) VM-1 covers essentially the same considerations as 1605.45B. Technology, feasible management and treatment opportunities to obtain the objectives stated in the manual will be considerred in deciding upon BMGs.

4. MFP Step 1, Watershed Management (1608.36A)

(a) VM-2 inputs Watershed Management Objectives (1608.36A). A scheme for determining if water quality problems exist will include the water quality objectives to be met and supporting rationale for various program categories. The objectives and rationale from VM-2 can be used directly for the objectives and rationale called for in MFP, Step 1.

(b) VM-5 will provide management practices to be used to accomplish the MFP objectives.

TABLE 4-1

BMP DEVELOPMENT/BLM PLANNING SYSTEM INTERACTION

	MODULE									
	1	3	VM 1	VM 2	VM 3	VM 4	16	25	VM-5	All
URA STEP 2										
1605.35A1b			x				x	x		
1605.35A2b			x				x	x		
1605.35B1b			x				x	x		
1605.35B2b			x				x	x		
1605.35A1c										x
1605.35A2c										x
1605.35B1c										x
1605.35B2c										x
URA STEP 3										
1605.45A1-3		x			x					
1605.45A1-6,8			x							
1605.45A7				x		x				
URA STEP 4										
1605.45B			x						x	
MFP STEP 1										
16-8.35A				x					x	

Chapter 5

RECOMMENDATIONS FOR PROGRAM MANAGEMENT IMPROVEMENT

WATER RESOURCE MANAGEMENT PROGRAM

The California BLM water resources program is in the developmental stage with the recent addition of a hydrologist to each of the California District staffs. The hydrologists will provide the lead for the water resources programming and further development of the 208 project and BMPs under the direction of the District Manager. This 208 water quality planning document and the methodologies described herein will provide a method for water quality management within the various resource management activities carried out by the BLM on public lands. The BMP development process must become an integral component of the BLM Water Resource Management Program.

Proper water resources management affects many functions of natural resource management, as water resources are integral to most land uses. The major component of first level water resource management is identification of water quality problems followed by a comprehensive monitoring program to assess the impacts of land uses on the water resources. Each district shall identify water quality problems associated with these natural resource management activities. A district-wide water quality monitoring program shall be developed in conjunction with ranking by priority mitigation of water quality problems. BMPs will focus on prevention or mitigation of these water quality problems. The hydrologist in each District in conjunction with other District resource specialists, shall develop BMPs for evaluation by the District Managers and then for implementation in the various district programs and planning processes.

Collaboration between the BLM and the State Water Resources Control Board is needed to secure cooperation for neighboring private landowners in efforts to implement BMPs. Most water sources mentioned in the problem assessments are only partly under BLM management.

BMPS FOR GRAZING AND RECREATION MANAGEMENT IMPROVEMENT

BMPs Applicable to Both Programs

Recommendations are included to improve water quality through better grazing and recreation management practices. In essence, these recommendations are BMPs of a general nature rather than site-specific BMPs arrived at through the methodology. When implemented, they promote water quality enhancement and protection. Incorporation of these recommendations into the BLM program is essential for the proper management of water resources.

(1) Activity plans and environmental impact analyses will be developed and reviewed incorporating water resource and soil capability considerations. The hydrologist, soil scientist and/or watershed specialist will be involved in an interdisciplinary effort to develop activity plans or environmental impact analysis reports at the District level. Activity plans and environmental impact analyses will consider impacts from the activity or proposed action to downstream and off-site beneficial uses of the water resources. It is essential that an evaluation of all impact analyses being made to insure that possible water resource impacts, mitigation, and degradation are adequately addressed.

(2) The RMP or activity plans should include vegetative cover objectives to protect the watershed from abnormal or excessive soil loss and erosion. Vegetative cover requirements will vary depending on type of use, soil characteristics, climatic factors, and vegetative types.

(3) Plans for construction and development of facilities for management resource must consider possible impacts on water resources and should include mitigative measures when adverse impacts are anticipated. Range improvements and recreation facilities are the major construction projects where the BLM is involved in alteration of the natural regime. These projects will be evaluated closely for possible water resource impacts.

(4) Streambanks and streambed integrity should be protected to minimize sedimentation and erosion. Stability in these critical areas is necessary to prevent abnormal soil movement. Sedimentation is objectionable primarily because of the fisheries and aesthetics of the water resource.

(5) Existing riparian vegetation along water courses should be protected. Growth and development of new riparian vegetation should be encouraged in areas where riparian vegetaion is sparse and is compatible with water quality objectives and other management goals.

(6) Proper distribution of resource users should be insured. Grazing animals should be distributed and recreational facilities located in a manner which protects the water resource from the impacts of over use and concentration.

(7) Critical environmental areas, such as unique water resource associated with unstable landscapes, should be protected to insure that use does not result in adverse impacts on water quality.

(8) The BLM should request funding through 208 for implementation of management practices or projects which protect or enhance water quality. To comply with the 208 plan, needed budget increases should be identified at the District level. Implementation plans should be developed for district problem areas.

(9) After plans are implemented, their effectiveness will be evaluated periodically.

BMPs for Grazing Management

(1) Adequate vegetation should be allocated for watershed protection to insure perpetuation of vegetative species, to maintain plant vigor and to attain stability. The percentage of forage necessary to provide adequate watershed protection should be identified in each MFP, AMP or other RAP.

(2) Climate trends and records should be evaluated during the development of AMPs, especially for season of use and forage productivity determinations. Climatic records provide a component of the data needed to determine average annual vegetative production.

(3) Supervision and compliance checks of livestock grazing permittees and lessees are essential to protect water resources. Restrictions and stipulations should be included in AMPs to protect or improve water quality. Compliance checks and use supervision should be carried out to insure compliance with the restrictions and stipulations.

(4) Range utilization and condition should be evaluated on an annual or seasonal basis. Close observation of the utilization at the end of the grazing season and the condition of the range before commencement of the grazing season is essential. Often overgrazing or deterioration of rangeland occurs because grazing capacity determinations do not reflect seasonal changes in vegetation.

(5) The Vegetation Inventory Method that addresses vegetation residual requirements will be used by each district to insure that an adequate portion of the forage allocation is retained for watershed protection.

(6) The Allotment Management Plan (AMP) will be sued to specify livestock numbers and season(s) of allowed use.

(7) The Bureau will continue to require the practice of herding so that domestic livestock will not impact water quality. Water can be hauled to the herd as a drinking supply. Sheep camps will not be allowed any closer than 1/4 mile to streams.

(8) When appropriate, water will be diverted away from a stream to concentrate livestock in areas away from the stream.

(9) Fencing will be used to control distribution of livestock along streams, when appropriate.

(10) Stocking rates will be adjusted, when apropriate, to protect water quality.

(11) Systematic grazing systems will be used as a method of protecting water quality. Monitoring of environmental conditions will be done to the extent necessary to correct any actions that are causing adverse impacts on water quality.

(12) Streambank rehabilitation projects will be implemented when deemed appropriate to protect water quality.

BMPs for Recreation Management

(1) Districts will provide safe drinking water supplies in developed campsites by sampling drinking water and correcting defective water systems.

(2) Sanitation facilities will be planned, located, designed, constructed, operated, inspected and maintained to minimize the possibility of both ground and surface water contamination.

(3) Users of BLM recreation facilities will continue to be encouraged to cooperate in the proper disposal of refuse.

(4) Trash receptacles will be placed at developed sites. Trash removal will culminate with disposal at a properly designed sanitary landfill (43 CFR 261.11)

(5) Recreation facility users will be requested to refrain from cleaning fish or food or washing clothes at hydrants or water faucets located in restrooms (43 CFR 261.14).

(6) Visitors are prohibited from operating off-road vehicles in a manner likly to cause damage to or disturbance of the land, wildlife habitat, or vegetative resources. This will assist in preventing excessive sedimentation resulting from such disturbance (43 CFR 295.2).

(7) Visitors are prohibited from depositing body waste except into receptacles provided for that purpose (43 CFR 261.14).

(8) The Bureau will be close areas to off-road vehicle use when that use is not consistent with multiple use and sustained yield principles.

APPENDICES

APPENDIX A

QUANTIFICATION

OF

WATER QUALITY CONSTITUENTS

INTRODUCTION

The purpose of this appendix is to describe, in further detail, how hydrologists use the process illustrated in the Problem Criteria Flowchart (Chapter VII) to determine the magnitude of water quality constituents. The process first asks the hydrologist to consider all possible constituents which may emanate from a specific management activity. Then the hydrologist must attempt to quantify constituents using the best available means. The means available to quantify constituents are: 1. using actual water data, 2. using loading functions to estimate loads of constituents, and 3. using professional judgement in assessing magnitudes of constituents. The most accurate and objective means is using actual water quality data while the most subjective means is using professional judgement in assessing magnitudes of constituents. Little water quality data is available on Bureau lands District hydrologists will have to rely on the less objective means of assessing constituents until water quality monitoring programs are well established. As the monitoring programs supply new water quality data, hydrologists will be able to improve their professional judgements.

If actual water quality data is not available loading functions and/or models which use information on the physical profile and use of an area can be used to estimate quantities of constituents. Since models and loading functions are empirically derived, they best describe the relationships which exist under the conditions and in the areas where they were developed. Some models are not sufficiently sensitive to predict constituents for localized areas or to predict peak loads which may accompany extreme hydrologic events. For these reasons loading functions and models should be used with discretion to assist in making decisions requiring professional judgement, or calibrated to fit specific purposes.

When water quality data is unavailable and no loading functions or models are applicable, the assessment of constituents must be based on the best professional judgement of the hydrologist and other involved district specialists. Best professional judgements can be based, in part, on observations of indicators of pollutants, on reports of adverse effects on water users, or on knowledge that a potentially water quality degrading management activity is occuring. Although it is subjective, this means of quanitifying water constituents is preferable to ignoring a potential pollution problem just because data needed to assess water quality or to use models and loading functions is lacking.

Once the water constituents have been quantified the hydrologist must determine if the constituents, at the observed level of magnitude, are causing a water quality problem. The process of water quality problem determination is addressed in Appendix.

Again, this Appendix describes the process of quantifying water quality constituents. The process is described for each pollutant which can emanate from management activities. The discussion of the sources of pollutants is ofen specifically related to grazing and recreation activities because the BLM was specifically charged by the State Water Resources Control Board to evaluate these two management categories. The remaining discussion of each pollutant, however, is generally applicable regardless of the source of the pollutant. A summarization of the major water quality impacts of grazing, recreation, and several other management categories is presented in Table A-1. This table does not include all impacts but rather only impacts which can generally be expected to occur from these activities.

SEDIMENT AS A WATER POLLUTANT

Various land management practices such as grazing or even recreation, if left unregulated, often result in excessive production of sediment. Sediment is probably the greatest single pollutant in terms of quantity and damage to the water resource when compared to any other nonpoint source of pollution. Sediment also has an interrelationship with other pollutants in that it acts as a carrier for pathogens, pesticides, organic matter, organic compounds, salts, nitrates, and phosphates. An interrelationship also exists with thermal pollution in that sediment-laden water tend to be somewhat warmer.

SOURCES OF SEDIMENT

The first step in the erosional process is removal or disturbance of the soil protective cover which can consist of vegetation, litter, gravel, or rock. Subsequent rainstorms, especially those of high intensity, causes detachment of soil particles by raindrops hitting the exposed soil at high velocities, shattering the soil granules and clods, reducing them to smaller particles, and sealing and reducing the natural infiltration rate of the soil, with the result that a mass of splashed soil is being transported downslope with the storm runoff water. As this excess runoff water begins to concentrate on slopes the force of the increasing velocities of this water begins to erode rills or even gullies as the excess sediment-laden water finds its way downslope into established runoff channels and streams. The erosional process continues and additional sediment is produced as this excess runoff becomes a flood flow where streambank cutting, fill-slope undercutting, channel cutting and scouring, channel deposition, channel meandering, and the physical transport of dissolved solids, debris, suspended sediment, and bedload movement all occur. In addition, in steep mountain areas of unstable geology, landslides and soil creep are often triggered by streambank undercutting.

This downstream movement and deposition of sediment causes major damage as stream channel integrity and capacities are altered or reduced. Sediment laden waters will cut out channels wherever stream velocities are high, but will deposit in channels wherever the natural velocity and the cutting energy is lowered such as by a reduced channel gradiant, greater channel size and capacity, less channel constrictions, and lower volumes of flow. As alluvial sands and gravels begin to be deposited throughout the flatter reaches of a stream, the channel is raised and subsequent flood flows will cut into the banks at outside bends enabling peak flows to flood over the bank onto adjacent floodplain lands, to flow over the land, concentrate on the floodplain and begin to discharge back into the channel, scouring out a new channel in the process, and bringing even more fine sediments into the stream system. The ultimate deposition point of sediments is in lakes, reservoirs, irrigation works, and ocean deltas. A common method of reservoir sediment control, however, is to flush out accumulated fine sediments by occasional opening of drain valves at the base of the dam thus further degrading downstream water quality.

Sediment is the most pervasive form of pollution. Deposited in water bodies, sediment covers fish spanning areas, clogs river channels, and coats lake bottoms, reduces light transmission in water, and increases pesticide and nutrient loadings through the chemicals and other pollutants it has absorbed. Water quality is thus impaired, navigation hampered, and aquatic life threatened. Fine-grained suspended sediment is especially threatening because of its affinity for association with available pesticides and nutrients, susceptability to further erosion and transport, and ability to pass over or through many of the applied erosion control measures.

Sediments in the stream further degrade the fishery habitat by tending to fill in pore space and cementing the stream natural spawning gravels into place such that fish cannot brush gravel aside to deposit eggs. Or if the eggs have already been deposited sediment will seal and block off the dissolved oxygen supply to the developing eggs such that the ova sufficates. Somewhat higher temperatures as a result of sediment inroads and more surface runoff further degrade the stream fisheries resource. While sediment can be filtered out of stream water many of the other organic compounds, dissolved salts, pathogens, and nutrients which sediment tends to transport, cannot be as removed as readily.

Management emphasis to reduce excessive runoff and sediment yields from upstream watersheds must be directed toward control over disturbance or removal of ground cover. Grazing removes part of this cover but if left uncontrolled could eliminate all of the vegetative cover. Various recreational activities, if unregulated, can also add significant amounts of sediment into the system wherever excessive ground disturbance is allowed to occur.

Improper Utilization of the range resource adds to the sedimentation, runoff, and stream channel problem in a number of ways. While grazing of the Western ranges is said to result in a widely scattered or nonpoint pollution it should be remembered that cattle and other grazing animals tend to be gregarious and will heavily concentrate on waterings, bottomland areas, mineral block locations, or sources of concentrated or high quality feed. The result is that in any pasturage system there will be areas which recieve animal concentrations approaching that of a feedlot. Feedlots of course are a point source of pollution under EPA terminology.

These areas of concentrated use have traditionally been accepted as "sacrifice areas" under which no amount of animal management can ever obtain or restore an adequate vegetative cover. The result of this grazing, particularly under conditions of poor or inadequate management, is the pollution of water primarily by sediment, nutrients, etc.

TABLE A1

LAND MANAGEMENT ACTIVITY CATEGORIES AND

MAJOR WATER QUALITY IMPACTS

Land Management Activity Category	PH	Temperature	Suspended Sediment	Nutrients	Dissolved Solids	Heavy Metals	Organic Matter (BOD)	Pathogens
Grazing		X	X	X	X		X	X
Recreation		X	X	X	X		X	X
Low Volume Roads		X	X					
Waste Disposal Sites	X		X	X	X	X	X	
Silviculture		X	X	X	X			
Fire		X	X	X	X			
Minerals	X		X		X	X		
Wildlife			X	X			X	X
Wild Horse and Burros			X	X			X	X

APPRAISAL OF SEDIMENT

When attempting to quantify the amount of sediment which is yielded from a watershed the person making the assessment must make sure that the approach will provide the information which is sought. A consideration of the nature of the sediment of concern i.e., suspended dissolved, or bed; the special distribution; and the level of reliability is needed. Dr. H. A. Einstein once suggested that the most reliable way to sample for bed-load sediment is with a bucket; the implication being that all of the sediment of concern needs to be collected. This of course is impractical for all but research purposes. However, direct field measurement is still the most reliable method of estimating sediment yields and effects. The Interagency Advisory Committee on Water Data has compiled what are considered the most acceptable and practical techniques available (USGS, 1977). Also the American Association of Civil Engineers in the development of a manual on sedimentation cites these same methods (Vanoni, 1975). Both committees stress that the accuracy of sediment discharge determinations is dependent not only upon the field methods and equipment utilized but also upon the knowledge of sediment distribution and transport processes in the stream or lake. An excellent indepth discussion of these variables can be found in Vanoni (1975). Many site specific decisions regarding sample location and specific measurement techniques will have to be made by the stream sampling personnel. In addition many site observations are a valuable aid that can increase the reliability of interpretation of the measured data.

The site provides valuable indicators which are related to the sediment transport processes. Off-site indicators of erosion such as; pedestals, erosion pavement, properties of the soil, gullies, etc., assist in determining how much soil is leaving a particular site. Stream channel characteristics including; temperature of alluvial deposition, bank condition, and fauna and flora provide insight about the nature of sediment delivery to the stream and the degree of impacts. During low flow periods these indicators may be the only reliable source of information about the quantity and nature of sediment being introduced to the channel. More practically, site observations should be included as a part of a sediment sampling program.

Since there are not current monitoring programs assessing sedimentation on a manageable watershed basis for BLM lands the information which will be gathered as a part of the BMP development processes will lack the time variation perspective. It has been supposed that 90% of the sediment delivered to a stream may occur during 10% of the climate events of the period.

The actual percentages are unimportant but the fact that a few events account for the majority of sediment transport is important. And that the trend of these processes appear to be cyclic further indicates that the data provided early in the monitoring schemes is of limited perspective. In such cases loading functions and erosion models can help broaden that

perspective. Unfortunately these models are less reliable as they are applied to areas further from the areas where they were developed. Table A-2 compares twelve approaches to estimating on-site erosion and sediment yield as described by the Pacific Southwest Inter-Agency Committee (PSIAC, April 1974). In reviewing the matrix it is evident that, depending on site factors, erosion process of concern, land use, cost, time and equipment available, each method has certain limitations. Because of this fact it is very difficult to specify pre erence for one of the methods over another. Rather, the choice undoubtedly falls to the person faced with making the prediction. The most desirable procedure is to use the method developed for conditions nearest to those for which an estimate is required. Predictive soil loss models can be used as one indicator of the effectiveness of BMPs. However these models should not be relied upon until they are adjusted, as mentioned above, for the area they are used in.

Recently, PSIAC developed an approach for estimating sediment yield. The method is a nine factor evaluation which was initially tested on 28 small watersheds in Colorado, New Mexico and Wyoming. The method holds some promise for general use in the west (Shown, 1970).

No matter what mathematical approach is used, empirical calibration will improve the reliability for use at any particular location. The data and time required to make such statistical adjustments will vary depending on site variability and deviation from the variables encountered on the idealized watershed that the formula reflects.

Efforts on the part of the hydrologist are necessarily directed at integrating measured data, site indicators, and models to the extent necessary to provide assessments at the level of reliabilty required for the situation at hand. More than anything else this requires foresight in the planning of monitoring programs to meet future needs.

TABLE A-2
SUMMARY TABLE OF ON-SITE EROSION AND
SEDIMENT YIELD METHODS

	Method	Geology and Soils						Climate			
		Proportion Nonerodible	Soil Size Distribution	Soil Density	% Organic	Soil Structure	Permeability	Annual Precipitation	Precipitation Intensity	Relative Rain Area	Annual Temperature
On Site Erosion	Bryan		X O		X O				X O		
	Foster and Meyer		X O						X O		
	Meeuwig	X O	X O	X	X O				X O		
	Meyer and Wischmeir		X O	X O					X O		
	Musgrave		X O			X O	X O		X O		
	Wischmeir and Smith		X O			X O	X O	X	X O		
Sediment Yield	Anderson	X	X					X	X O	X O	
	Branson and Owen		X								
	Flaxman		X O					X O			X O
	Negev		X						X		
	Renard										
	Tatum								X O		

X Data Needed to Formulate Method
O Data Used to Solve Derived Method
Taken From: Shane 1970

TABLE A-2 (continued)
SUMMARY TABLE OF ON-SITE EROSION AND
SEDIMENT YIELD METHODS

	Method	Runoff		Topography						
		Runoff	Stream Hydrograph	Slope	Slope Length	Area	Drainage Density	Relief Ratio	Shape of Basin	Angle of Junction
On site Erosion	Bryan			X O						
	Foster and Meyer			X O	X O					
	Meeuwig			X O						
	Meyer and Wischmeir	X O		X O	X O	X O				
	Musgrave			X O	X O					
	Wischmeir and Smith			X O	X O					
Sediment Yield	Anderson	X O	X	X O		X O			X	
	Branson and Owen	X		X			X O	X O		X
	Flaxman	X O		X O						
	Neoev		X							
	Renard	X O	X O	X O		X O				
	Tatum			X O			X O		X O	

X Data Needed to Formulate Method
O Data Used to Solve Derived Method

TABLE A-2 (continued)
SUMMARY TABLE OF ON-SITE EROSION AND
SEDIMENT YIELD METHODS

	Method	Ground Cover			Land Use				Upland Erosion	
		%Bare Ground	Effect of Fire	Vegetative Cover	Roads Urban	Practice Factor	Grazing	Logging	Test Plots	Farm Ponds
On site Erosion	Bryan								X	
	Foster and Meyer								X	
	Meeuwig			X O					X	
	Meyer and Wischmeir								X	
	Musgrave					X O			X	
	Wischmeir and Smith					X O			X	
Sediment Yield	Anderson		X O	X O	X O		X	X		
	Branson and Owen	X O								
	Flaxman									X
	Negev									
	Renard									
	Tatum		X O							

X Data Needed to Formulate Method
O Data Used to Solve Derived Method

TABLE A-2 (continued)
SUMMARY TABLE OF ON-SITE EROSION AND
SEDIMENT YIELD METHODS

	Method	Channel 1/ Erosion and Sediment Transport			Cost of Field Data			Method of Solution		
		Channel X-Section and Slope	Suspended Load	Reservoir Sedimentation	Low	Medium	High	Analytical	Nomograph Charts	Computer
On-site Erosion	Bryan									
	Foster and Meyer					*		*		
	Meeuwig					*		*	*	
	Meyer and Wischmeir				*			*		
	Musgrave				*			*		
	Wischmeir and Smith					*		*	*	
Sediment Yield	Anderson	X	X	X O			*	*		*
	Branson and Owen			X	*			*		
	Flaxman			X	*			*		
	Negev		X							
	Renard	X O	X	X		*				*
	Tatum			X	*				*	

X Data Needed to Formulate Method
O Data Used to Solve Derived Method
* Miscellaneous Information on cost and Data Output
1/ Channel Slopes are Needed for Renard's Method

TABLE A-2 (continued)
SUMMARY TABLE OF ON-SITE EROSION AND
SEDIMENT YIELD METHODS

	Method	LIMITATIONS AND APPLICABILITY
On site Erosion	Bryan	No predictive equation, data relates soil erodibility to water soluble aggregates > 3 mn
	Foster and Meyer	Equation universally applicable if coefficients are determined.
	Meeuwig	Equations determine relative erodibility but at a constant rate of precipitation
	Meyer and Wischmeir	Equation universally applicable but coefficients difficult to determine.
	Musgrave	Equation universally applicable but limited to slopes less than 20 percent.
	Wischmeir and Smith	Equation universally applicable but limited to slopes less than 20 percent.
Sediment Yield	Anderson	Equation applicable mainly in large watersheds but needs sediment transport data.
	Branson and Owen	Equation universally applicable but correlation coefficients for each area must be determined.
	Flaxman	Equation universally applicable especially in western United States.
	Negev	Equation universally applicable but needs precipitation and runoff data.
	Renard	Equation applicable universally if runoff generation method available.2/
	Tantum	Equation applicable to southwestern United States, needs precipitation and burn effect data.

X Data Needed to Formulate Method
O Data Used to Solve Derived Method
* Miscellaneous Information on cost and Data Output
1/ Channel Slopes are Needed for Renard's Method
2/ Used with Ephemeral Stream Model in southwestern United States
Taken from: Shane 1970

THERMAL POLLUTION

SOURCES OF THERMAL POLLUTION

Solar radiation is the principal energy source responsible for raising the temperature of streams which flow through lands administered by the BLM in California. For management activities such as grazing and recreation, the removal of the shade producing vegetative cover is the primary mechanism through which solar radiation is allowed to strike the stream surface. Modification of other stream conditions can also affect changes in stream temperature. Reduction in the rate of flow or increasing the proportional surface area of a stream, both which can occur as a result of channel agradation due to sediment increases, can cause an increase in stream temperature. A change in the composition of bottom materials can have an effect on stream temperature. Brown (1972) found that about 20 percent of the net incoming radiation may be transfered to bed material where the streambed is composed of bedrock. He compared this to an insignificant amount transfered to beds consisting of gravel sized materials. Where management practices alter the volume of subsurface cooling water, such as in-channel seepage and springflow, a marked change in stream temperature would likely occur.

The recreation and grazing activities that effect the shade producing vegetation along a stream are basically the same. Direct removal of the brushy vegetation by trampling or cropping has the most obvious effect on smaller streams and headwater tributaries. Repeated uncontrolled travel to the water tends to develop pathways which attract more extensive use and further vegetation removal. With continuous use, the streambank soil becomes compacted which alters properties of the soil necessary for plant growth. As the volume of macropore space is reduced the gaseous exchange processes are retarded affecting microbial activity and the osmotic process in roots. Infiltration is also slowed, altering the availability of dissolved nutrients to plants. With a sufficient degree of compaction, physical impedence of root penetration can occur. In addition, with a decrease in infiltration capacity, overland flow will occur more often. The removal of the nutrient horizon of the soil through erosional processes will proceed at an accelerated rate. The effect of these interactions are compounded further by direct damage of exposed roots. While trees respond in a similar way to the alteration of soil properties discussed for brush, their shade producing canopy is also influenced by other conditions which result in or from reduced tree vigor. For example, alteration of the root environment will have a marked effect on the trees vigor and consequently on its susceptibility to insects and disease. A significant amount of stem damage could also reduce vigor. In contrast to brushy vegetation, trees may provde shade to larger streams and at a greater distance from the channel. The actual growth response to a given level of use will vary, depending on the characteristics of the soil and the nature of the vegetation.

Erosion is the primary process affecting the channel features responsible for stream temperature maintenance. As such, application of good erosion control techniques which are required to minimize the production of sediment and its effects on downstream beneficial uses is usually sufficient to avert any adverse effects on stream temperature.

APPRAISAL OF THERMAL POLLUTION

As is the case with other pollutants, the most reliable information of stream temperature fluctuations is by direct measurement. The sampling scheme may vary from one stream to the next, depending primarily on the beneficial uses being effected and the critical period of concern. However, stream sampling schemes generally have three main objectives. They are: to provide data on background or baseline conditions, to identify the effect of an activity, and to provide a means for predicting the effects of a proposed activity. Several years of data taken in a manner which reflects diurnal and seasonal fluctuations is required in order to provide an understanding of background (or baseline) conditions. Where there is sufficient control of variables, comparison watersheds can usually provide adequate information to supplement existing on-site data in most field applications.

Bracket (or "above and below") sampling during the period of concern for pollutants which could be impacting beneficial uses will generally provide sufficient information from which to establish correlative relationships between an activity and water temperature changes. Care must be taken to exclude or account for non-activity related effects, e.g., dilution cooling (or geothermal heating) by inflow water, or areas naturally exposed to direct solar insolation. With sufficient background data, it would only be necessary to bracket monitor for a couple of seasons to establish a practical level of confidence in the relationships. For stream temperature prediction, direct measurement will have to be supplemented with an appropriate model and tempered with professional judgement so that recommendations can be made.

There are two methods which are acceptable for universal application in the Pacific West. The micrometerological approach, which requires a prohibitive investment in time and equipement for normal field application, is discussed by Brown (1969). Subsequently, George Brown developed an abbreviated temperature prediction model based on his previous observation that over 95 percent of the energy exchange on exposed streams could be accounted for by net radiation alone (Brown, 1970). Further modification of the model was made in 1972 to account for flow through pools when a significant number of unmixed pools are present, and to account for the energy absorption in bedrock channel bottoms. This model provided a predicted maximum temperature change on a fully exposed small stream within 2-3 ^{o}F of that which was observed. It is not expected that this reliability would occur universally in hydrologic settings which are dissimilar to the research streams of the Oregon Coast and Cascade Ranges. However, with a reasonable amount of background information the model could be empirically adjusted to fit local conditions. The major source of error with these techniques is reflected in observation errors and sampling errors. Observation errors

include erroneous judgements as to the amount of area of dynamic flow in pools, whether mixing is occuring in pools, and whether other factors are influencing water temperature such as, subsurface inflow. Measurement errors occur in flow measurements and surface area measurements. Both types of errors are magnified with lower and slower flows. It also must be kept in mind that this model can only be used to predict the temperature change which would result for complete removal of shade cover.

Brazier (1973) presented a method for determining what vegetation (or landscape features) is providing shade to a stream during periods of concern. This approach is field expedient and is used to indicate what vegetation would affect the amount of net solar radiation transmitted to a stream. It should be noted that the method was not designed to predict the amount of solar insolation reaching a stretch of stream from which vegetation was partially removed. A simplified photograph approach has been developed which, unlike Brazier and Brown's can be used to indicate shade producing cover for all sun declinations and all hours of day in one sighting. However, since film development time is required it does not lend itself well to on-site determinations. This method could be adopted for instream determinations by using a mirror instead of a camera. Similar to Brazier and Brown's method, the photographic method does not account for all of the variability encountered along the entire stream segment, only those variables where the sample siting was taken. Therefore with both methods, the more sites which are sampled, the better the predictions will be (refer to Appendix for the application of both methods).

Management activities associated with grazing and recreation do not significantly alter the temperature patterns in lakes and reservoirs. However, the construction of an impoundment will result in the water temperature in the reservoir being elevated over that of the inflow waters. Depending on the design of the outflow (if discharge is intended) downstream water temperatures could also change.

Indicators of stream temperature changes are not considered as being a reliable source for identifying correlative relationships between management activities and stream temperature. Such indicators as the character of algal blooms, changes in taste and color, changes in aquatic composition (including bacteria), and fish growth characteristics do however, provide insight into the effects of stream temperature on various beneficial uses.

Temperature of natural water is one of the key factors of the aquatic environment which controls what will live there. Fish growth and reproduction are most directly effected by temperature. The tolerance of organisms to extremes of temperature is a function of the genetic ability to adapt to thermal changes within their characteristic temperature range, the acclimation temperature prior to exposure, and the time of exposure to the elevated temperature (Contant 1972). Table A-3 shows the calculated mean weekly temperature at which growth ceases. For example, if summer temperatures averaged 19 ^{o}C over a one week period no growth would be expected for rainbow trout. This condition would exist only if a maximum

temperature of 24 °C was not attained during the week. The "maximum" temperature shown in Table A-3 is considered to be the temperature at which only a few fish would perish if they were acclimated to the maximum weekly average temperature ("Growth" temperature). Therefore, if rainbow trout had acclimated to the 19 °C condition and the temperature rose to 24 °C a few fish would be expected to die. Since a factor of safety of 2 °C has been applied in the formula, 50 percent mortality would be expected at 26 °C. Table A-4 identifies the optimum temperature of spawning and the maximum temperature for successful incubation and hatching of fry. Uniform deviation from the optimum spawning temperature can effect the time of juvenile emergency which could be detrimental if not commensurate with food source availability.

Aquatic organisms other than fish can also be effected by changes in water temperature. Increased temperature may effect periphyton, benthic invertebrates, and algal communities. There is very little definitive information available regarding the impacts that would be expected on the aquatic community from temperature changes typically associated with grazing and recreational activities. For bentic organisms, approximately 32 °C is considered the upper limit for balanced population structure (FWPCA, 1967). However, individual species requirements differ greatly. For example, a species of may fly (cinygmula par) is known to die when exposed to a temperature of 11.7 °C. On the other extreme the snipe fly (Atherie variegata) could survive temperatures near 32.6 °C (TLM) (Gaufin, 1973). Further results from Gaufin's work on temperature effects on aquatic insects are included in Table 5 A-5, 6, 7, and 8.

Water temperature effects other uses indirectly; for example increased temperature accelerates the biodegradation of organic material, thus increasing demands on the dissolved oxygen resources of a given system. This, along with a decrease in oxygen solubility with increased temperature may lead to septic conditions and subsequent volitalization of odor producing compounds. Odor problems associated with plankton may also be aggravated. Indicator enteric bacteria are known to increase with temperature and presumably enteric pathogens are likewise affected by temperature.

It is evident that increases in water temperature can have both positive and negative influences on the beneficial uses of water from public lands. Those most directly affected are associated with aquatic habitats and contact recreation. Human consumption and livestock consumption are more indirectly affected by the temperature influence on other stream qualities.

A great deal of good judgement and careful monitoring will be necessary in order to accurately assess the current temperature conditions in a stream or to project the result of proposed management activities.

TABLE A-3

Example calculated values for maximum weekly average temperatures for growth and short term maxima for survival of juveniles and adults during the summer; centigrade and (fahrenheit).

Species	Growth	Maximum
Atlantic Salmon	20 (68)	23 (73)
Bigmouth Buffalo		
*Black Crappie	27 (81)	
*Bluegill	32 (90)	35 (95)
*Brook Trout	19 (66)	24 (75)
*Carp		
*Channel Catfish	32 (90)	35 (95)
*Coho Salmon	18 (64)	24 (75)
Emerald Shiner	30 (86)	
Freshwater Drum		
Lake Herring (Cisco)	17 (63)	25 (77)
*Largemouth Bass	32 (90)	34 (93)
Northern Pike	28 (82)	30 (86)
*Rainbow Trout	19 (66)	24 (75)
Sauger	25 (77)	
*Smallmouth Bass	29 (84)	
Smallmouth Buffalo		
Sockeye Salmon	18 (64)	22 (72)
*Striped Bass		
*Threadfin Shad		
*White Bass		
*White Crappie	28 (82)	
White Sucker	28 (82)	
*Yellow Perch	29 (84)	

* Found in California

From : Contant 1972

TABLE A-4

Summary of reported values for maximum weekly average temperature for spawning and short term maxima of embryo survival during the spawning season; centigrade and (fahrenheit).

Species	Growth	Maximum
Atlantic Salmon	5 (41)	11 (52)
Bigmouth Buffalo	17 (63)	27 (81)
*Black Crappie	17 (63)	20 (68)
*Bluegill	25 (77)	34 (93)
*Brook Trout	9 (48)	13 (55)
*Carp	21 (70)	33 (91)
*Channel Catfish	27 (81)	29 (84)
*Coho Salmon	10 (50)	13 (55)
Emerald Shiner	24 (75)	28 (82)
Freshwater Drum	21 (70)	26 (79)
Lake Herring (Cisco)	3 (37)	8 (46)
*Largemouth Bass	21 (70)	27 (81)
Northern Pike	11 (52)	19 (66)
*Rainbow Trout	8 (46)	15 (59)
Sauger	12 (54)	18 (64)
*Smallmouth Bass	17 (63)	23 (73)
Smallmouth Buffalo	21 (70)	28 (82)
Sockeye Salmon	10 (50)	13 (55)
*Striped Bass	18 (64)	24 (75)
*Threadfin Shad	18 (64)	34 (93)
*White Bass	17 (63)	26 (79)
*White Crappie	18 (64)	23 (73)
White Sucker	10 (50)	20 (68)
*Yellow Perch	12 (54)	20 (68)

* Found in California

*TABLE A-5

Long-Term Thermal Bioassays

Biological Station (Thru March 23, 1970)

Species	24 days	30 days	25 days	45 days	12 days
Pteronarcella badia (Hagen)	18.1° C				
Pteronarcella badia (Hagen)		20.5° C			
Pteronarchys californica Newport			20° C		
Brachycentrus occidentalis Banks				26° C	
Ephemerella grandis Eaton					21.5° C

Tables A-5, A-6, A-7, A-8, Taken From: Gaufin Arden R. (1973) Water Quality Requirements of Aquatic insects. EPA 660/3--73-004 Ecological Resource Series.

Table A-6 Temperatures (^{o}C) at which 50% of the test species died after 96 hours exposure (TLm^{96}), Bigfork, Montana, 1968-69.

Species tested	Test 1	Test 2	Test 3	Mean TL3	Average group TLm
DIPTERA					
Atherix variegata Walker	32.6	32.2	....	32.4	28.7
Simulium sp.	25.0	25.2	....	25.1	
TRICHPTERA					
Parapsyche elsis Milne	21.8	21.6	....	21.7	
Limnephilus ornatus Banks	24.5	25.0	....	24.75	
Neothrema alicia Banks	25.8	26.0	....	25.9	26.5
Drusinus sp.	27.2	27.4	....	27.3	
Bachycentrus occidentalis	29.7	....	....	29.7	
Hydropsyche sp.	30.0	30.1	....	30.05	
PLECOPTERA					
Isogenus aestivalis (Needham and Claassen)	16.0	16.3	....	16.15	
Pteronarcella badia (Hagen)	24.4	24.6	24.2	24.4	22.55
Pteronarcys californica Newport	28.0	26.4	26.6	27.0	
EPHEMEROPTERA					
Cinygmula par Eaton	11.7	....	....	11.7	
Ephemerella doddsi Needham	15.4	15.5	....	15.45	18.82
Ephemerella grandis Eaton	21.5	....	....	21.5	
Hexagenia limbata Guerin	26.1	27.1	....	26.6	
AMPHIPODA					
Gammarus limnaeus Smith	14.5	14.6	....	14.55	14.55

*Table A-7

Long-Term Thermal Bioassays

University of Utah

1970-71

Species tested	Temperature	Exposure time (days)	% Survival
PLECOPTERA			
Acroneuria pacifica Banks	15 °C	31	50%
Arcynopteryx signata (Hagen)	15 °C	14	60%
Arcynopteryx parallela Frison	15 °C	41	55%
Brachyptera nigripennis (Banks)	14.5°C	5	50%
Isoperla fulva Claassen	18 °C	11	40%
Pteronarcella badia (Hagen)	17.5°C	38	45%
EPHEMEROPTERA			
Ephemerella grandis Eaton	17.5°C	18	50%
Rhithrogena robusta Dodds	15 °C	4	50%
TRICHOPTERA			
Arctopsyche grandis (Banks)	18.0°C	23	50%
Brachycentrus occidentalis Banks	28.0°C	14	45%
Parapsyche elsis Milne	15.0°C	14	40%
Rhyacophila fuscula	15.0°C	39	40%
DIPTERA			
Bibiocephala grandis	15.0°C	36	60%
Atherix variegata Walker	28 °C	46	50%
Holorusia grandis	24 °C	31	45%
ODONATA			
Argia vivida	18 °C	29	50%

Table A-8. Temperatures (^{o}C) at which over 50% of the test species survived after 96 hours exposure (TLm_{96}), University of Utah, Salt Lake City, Utah, 1970.

Species tested	% Survival	Temperature	
PLECOPTERA			
Acroneuria pacifica Banks	70%	27.0	
Isogenus aestivalis (Needham and Claassen)	50%	24.2	
Arcynopteryx parallela Frison	70%	23.0	
	45%	18.0	(Winter test)
EPHEMEROPTERA			
Ephemerella doddsi Needham	50%	22.0	
	60%	16.0	
TRICHOPTERA			
Brachycentrus occidentalis Banks	60%	29.0	
	70%	28.0	
Arctopsyche grandis (Banks)	40%	20.0	
DIPTERA			
Atherix variegata Walker	100%	29.0	
Holorusia grandis	80%	26.0	
	0%	28.0	

*Long-term tests were conducted at the Biological Station through March, 1970, at which time a breakdown in the heating system necessitated transferring the work to the University of Utah. In the work conducted in Montana a species of stonefly, *Peronarcella badia*, was most sensitive with 50% of the test specimens succumbing to a temperature of 18.1^{o} C in 24 days. *Brchycentrus occidentalis*, a case making caddis fly, was least sensitive withstanding a temperature of 26^{o} C for 45 days. The sensitivity of the former species to longer term exposure was a decided contrast to its tolerance of temperatures as high as 24.6^{o} C for short-term exposures. Since the specimens involved in the longer term tests were collected during the winter months, it is possible that acclimation to low winter termperatures increased the sensitivity of the specimens tested.

BIOLOGICAL POLLUTION

If not the most universally occurring pollutant on public lands, biological pollutants have the potential for resulting in the most serious impacts. The nature of biological pollutants are rather diverse, including all forms of living organisms not naturally occurring in a water body or in numbers which exceed normal populations.

In the restricted sense, biological pollutants as used here are delivered to a water body from nonaquatic or offsite sources. As such, alteration of aquatic biology by the delivery of nonbiological sources i.e., those which occur in accelerated eutrophication, is discussed in another section.

Biological pollutants are considered to be either objectional in nature or pathogenic. The distinction between the two in actual occurrance is not very clear; nor possibly does it need to be since an objectional situation; i.e., odor, color, etc, is usually associated with a pathogenic one. Of greater importance is the identification of sources of pathogenic organisms and the evaluation of the significance of the potential impacts which are associated with them. Unfortunately, the source-delivery-impact relationship is vertually unexplored in wildland settings.

In the past century a good deal of progress has been made in identifying pathogenic organisms in general and the diseases that they cause.

SOURCES OF BIOLOGICAL POLLUTION

Even before the relationship between micro-organisms and disease was understood, it was recognized that water could act as a medium for the transference of disease. As early as 1854 Dr. John Snow demonstrated conclusively that transmission of Asiatic cholera through drinking water was the cause of the London cholera epidemic which resulted in excess of 7000 deaths that year. In 1880 Von Fritsch identified Klebsiella spp in human feces thereby establishing a cause-effect relationship of disease transmission. Later Escherich confirmed that the relationship between fecally-associated microbes and potential disease, when he described Bacillus coli (later Escherichia coli) as an indicator of pollution.

Since the time that Anton Van Leeuwenhoek first dicovered the world of micro-organisms in a drop of water in the mid 1600's a multitude of pathogens have been classified and many more are still to be identified. Basically they fall into a few broad groups. They include; bacteria, viruses and richettsiae, fungi, single celled animals e.g., protozoa, and multicellular parasites e.g., Nematodes. A few of the more important microbial diseases are listed in Table A-9.

Not all pathogens can survive in an open water environment and fewer still are capable of growth. This is due to a number of restrictive variables; antibiosis, competition, sunlight, temperature, sedimentation, pH, available food supply and nature of the pathogen all play a role in pathogenic survival. An exhaustive treatment of the limiting conditions required for contamination of water sources would be both complex and sketchy and is not within the scope of this document. It would, however, be safe to assume that any water which is accessible to mammals, including man, has some degree of contamination.

Micro-organisms which are capable of producing disease in humans find their way into waters almost wholly through urinary and fecal excretions. A few organisms are so ubiquitous that carrier sources are not distinct for any particular waters. Such organisms include bacterias like Salmonella, those viruses responsible for hepatitus infections, and zoonotic forms like Giardia lamblia. In livestock, infection may also occur as a result of exposure to internal organs of infected carcasses or the placental discharges which are frequently associated with pathogenic caused abortions.

Delivery to a water body can be by direct delivery as would occur where livestock have access to the surface water or where recreationists can indiscriminately dispose of waste directly in the water. The latter could occur during both contact or noncontact recreation. Some pathogenic organisms can survive extended periods of time in the soils and later be washed into a water body by overland storm flow (Aukerman, 1976). Contamination of groundwater has been known to occur through runoff into improperly sealed well systems. Poorly located septic systems, such as outhouses, can also contaminate groundwater. Areas with high water tables or where soil and bedrock are very pervious have the greatest probability of groundwater contamination. Similarly indiscriminate dumping of holding tanks from self contained recreational vehicles can result in groundwater contamination. In a wildland setting leaching of pathogens from manure is not considered to be a problem; although areas of concentrated manure accumulation, e.g., feed lots, have been known to cause contamination.

APPRAISAL OF BIOLOGICAL POLLUTION

The uses which require uncontaminated water on BLM administered lands are associated with domestic, recreation, and livestock drinking water supplies, as well as contact recreation. There is no single procedure that can be used to isolate and identify pathogenic organisms which could transmit diseases to these public lands users. Salmonella are extremely common in the environment and are probably responsible for most recognized water borne disease outbreaks. Unfortunately, isolation techniques even for these ubiquitous organisms involve complicated procedures. Monitoring of water for enteric viruses is extremely difficult requiring specialized laboratories with a virologent staff. Attempts have been made to provide a more practical approach to setting standards of safe water conditions for various uses. Currently the most widely accepted approach is the quantification of indicator organisms; specifically coliform bacteria. The use of coliform bacteria as an indicator has been the subject of continuous debate. The U.S. EPA (1976) provides insight into the relevant arguements. Regardless of the limitations of their use, coliform counts and ratios are currently used as the standard of measure for fecal contamination of water. Due to the long survival time of Streptococus fecalis (70% after one day in water, as opposed to 20% for fecal coliform), fecal strep examination is usually performed along with coliform examination. Other pathogenic examinations are appropriate when the presence of organisms which do not correlate with the coliform index is suspected. Recently, Giardia lamblia has become a concern due to this lack of correlation as well as the fact that chlorination is not an effective water treatment. Pathogens which are suspected of causing a significant problem should be examined in conjunction with standard coliform examination. A regular surface and groundwater monitoring program is the most practical method of assessing the magnitude and nature of organisms where a biological problem is suspected.

Historically problems associated with water-borne pathogens have been suspected only when infectious diseases have occurred following water contact. It has been postulated that in a 10 year period there might have been as many as 2.5 million incidents of clinical disease in the U.S. resulting from water-borne pathogens; of which only about 10% were actually reported (McDermott, 1975). Therefore, in order to protect human health, it may be more prudent to identify suspected waters before an illness is known to have been contracted. Indicators of suspicious conditions would include extensive contact with the water by warm blooded animals, indications of fecal and urinary contamination, and odor. A knowledge of the existing use of the water and condition of associated facilities; e.g., well casings, etc., would be helpful in determining significance of any impacts which might occur. Specific site conditions and the nature of the organisms will dictate whether to remove the source, treat the cause, or to cure the disease once contracted.

TABLE A-9

A PARTIAL LIST OF MICROBIAL DISEASES TRANSMITTED BY THE WATER CONTACT

Disease	Etiologic Agent	Occurrence	Symptoms	Reservoir and Source of Infection	Mode of Entry	Incubation Period	General Control of the Water Contact
Typhoid Fever	Salmonella typhi	Worldwide. U.S.:	Systemic infection with high continued fever, lymphoid tissue involvement, rose spots on trunk, nausea, vomiting, diarrhea or constipation. spleen enlargement, abdominal tenderness.	Feces and urine of infected humans, carriers are important in transmission; 2-5% of cases become permanent carriers, Carrier state more frequent in women over 40.	Oral consumption	7-29 days Usually 2 weeks	Protection and treatment of water supplies; sanitary disposal of human excreta; supervision of carriers; education; boiling of water; (personal hygiene, Fly and Vector control, Food and Milk Control, Pasteurization. Immunization, Shellfish sanitation Cholecystectomy).*
Paratyphoid Fever (A) Salmonella paratyphi (B) schottmuelleri, (C) hirschfeldi, Typhimorium Spp		Worldwide, U.S.: B-type common. Incidence declining with that of typhoid.	Generalized infection with abrupt onset of headache, profuse persperation, continued fever, enlarged spleen, abdominal pain, nausea, vomiting, usually diarrhea. Onset of B and C types more acute, Rose spots on trunk. Milder than typhoid.	Feces and urine of infected humans, (Cases and carriers)	Oral consumption	1-10 days somewhat longer for type A	Same as typhoid; carrier supervision not practical.
Shigellosis (Bacillary Dysentery)	Shigella Various species Examples; S. sonne, flexner, shiga dysenteriae,	Worldwide, U.S.: More common than generally recognized. Significant portion of unreported diarrhea,	Acute infection with fever cramps, malaise, diarrhea, blood, pus, and mucus frequently in stools, Mild to severe.	Feces of infected humans A few individuals become a carrier for a year or two, rarely longer. Many	Oral consumption	1-7 days Usually 4 days or less	Same as typhoid, but eliminate immunization; carrier supervision not practical. (Sanitary supervision of source, processing, preparation and serving of foods, particularly moist foods , and foods eaten raw.)

* Indicate important items for controlling the disease but not associated with the water vehicle.

TABLE A-9 (continued)

A PARTIAL LIST OF MICROBIAL DISEASES TRANSMITTED BY THE WATER CONTACT

Disease	Etiologic Agent	Occurrence	Symptoms	Reservoir and Source of Infection	Mode of Entry	Incubation Period	General Control of the Water Contact
	bodyii	more common and severe in children. Institutional outbreaks are frequent.		inapparent, mild and unrecognized infections.			
Amebiasis (Amebic Dysentery)	Entamoeba histolytica	Worldwide, U.S.: An infection level of from 6-10%. Mental Institutions. Seldom in cattle	Abdominal discomfort, diarrhea, constipation, blood and mucus may be observed in stools, May spread to blood stream causing organic infections. Asymptomatic or mild.	Human feces containing cysts. (Chronic or asymptomatic cases)	Oral consumption	5 days-several months commonly 3-4 weeks	Same as above; more resistant to chlorination. Iodine can destroy organism
Infectious Hepatitis	Virus of infectious hepatitis	Worldwide, U.S.: Rural and in institutions. More common in children. Horses.	Fever, anorexia, lassitude, malaise, abdominal discomfort, bile in urine, jaundice.	Feces and blood from infected persons. Few days before to few days after onset.	Oral consumption	10-40 days Commonly 25 days	Water filtration; santary disposal of human excreta; education; boiling of water; (Personal hygiene, sterilization of hypodermic needles, shellfish and food sanitation; Prophylaxisimmune serum globulin).*

TABLE A-9 (continued)

A PARTIAL LIST OF MICROBIAL DISEASES TRANSMITTED BY THE WATER CONTACT

Disease	Etiologic Agent	Occurrence	Symptoms	Reservoir and Source of Infection	Mode of Entry	Incubation Period	General Control of the Water Contact
Cholera	Vibrio cholerae	Endemic in S.E. Asia, U.S.: None	Sudden onset, vomiting profuse watery diarrhea, rapid dehydration and collapse.	Feces and vomitus of infected human cases, of persons incubating the disease and of convalescents.	Oral consumption	Few hours-5 days commonly 3 days	Same as typhoid; carrier supervision of no value
	Vibrio fetus	Sheep in U.S. most in Rocky Mountains	Abortion in late pregnancy	Cattle and Sheep Placental fluids Aborted fetus	Oral comsumption	10-21 days	
Tularemia	Pasteurella tularensis	North America, Europe, Japan, cows, sheep, wider variety	Sudden onset, chills and fever, prostration, lymph nodes swollen and tender and may suppurate.	Lesions, sputum from species of infected wild many and some domesticated animals. Ticks.	Oral consumption, Skin abraisons	1-10 days commonly 3 days	Avoid drinking raw water in areas where the disease prevails among wild animals; protection and treatment of water supplies; education; (rubber gloves for dressing rabbits. avoid tick bites). Inoculation.
Leptospirosis (Well's Disease)	Leptospira species, Example; canicola. ictero-hemorrhagiae	Worldwide. Occupational hazard to those associated with animals. Swimmers exposed to contaminated water. Cattle, Sheep, horses, wildlife.	Fever, chills, severe malaise, muscular aches, headache, vomiting, stiff neck, jaundice, hemorrhage in skin and mucous membranes, renal insufficiency.	Urine of infected dog, swine, rodents, cattle or other animal.	Presumably penetration of abraded skin or mucous membrane, possibly from ingestion	4-19 days Usually 10 days	Avoid swimming in potentially contaminated water; water supply protection. (Boots and gloves for those exposed to hazard, Rodent control).*
Innoculation Lupus Vulogris	Mycobacterium bilnei.	North America Europe, cattle	Pin head to pea size papular lesion of	Urine or sputum of infected humans	Invasion following	3-6 weeks	Smooth wall construction of pools and break point

TABLE A-9 (continued)

A PARTIAL LIST OF MICROBIAL DISEASES TRANSMITTED BY THE WATER CONTACT

Disease	Etiologic Agent	Occurrence	Symptoms	Reservoir and Source of Infection	Mode of Entry	Incubation Period	General Control of the Water Contact
(Granulomatous Tuberculosis Lesions)	*tuberculosis*, *marinum* *Paratuber-culosis*		spongy consistency; crusting and scaling of surrounding skin, thick secretions develop under crust leaving bluish-red soft scar at elbows knees, ankles and bridge of nose.		trauma at swimming pools		chlorination
Schistosome Dermatitis (Swimmers Itch)	Schistosoma larvae, (many species)	Worldwide, (Lake and Coastal areas). U.S.: North central states	Dermatitis, prickling sensation and intense itching	Feces and urine of infected birds and animals to snails to free swimming cercariae.	Skin pene-tration	Immediately after leaving water- few hours	Snail control; avoid cercariae infected waters

ORGANIC MATTER AS A WATER POLLUTANT

The importance of organic matter as a water pollutant results from its impacts on other water quality parameters, primarily dissolved oxygen. The basic chemical reaction in the microbial decay of organic matter, where organic matter is represented by CH_2O, is: $CH_2O + O_2 \longrightarrow CO_2 + H_2O$. This reaction results in depletion of oxygen and production of carbon dioxide. The biodegradation of organic material, however, is only part of the complex systems which control both dissolved oxygen and carbon dioxide-carbonate equilibria. An explanation of these systems is required in order to understand the impacts of organic matter on water quality.

DISSOLVED OXYGEN DEPLETION

Without an adequate level of dissolved oxygen, aquatic animals cannot survive. Many fish kills result not from the direct toxicity of pollutants, but from oxygen depletion caused by oxygen demanding substances.

As oxygen is consumed, it must be replenished if aquatic life is to be maintained. Unlike many other essential nutrients, however, there is no sink which provides for the replenishment of oxygen. The primary mechanism for re-oxygenation is direct water contact with air. This re-oxygenation process is facilitated by turbulent flow. Dissolved oxygen is also provided through the photosynthetic activity of aquatic organisms. This source is not an efficient means of re-oxygenation, however, since some of the oxygen produced during the daylight hours is consumed by the nighttime metabolic processes of photosynthetic organisms. Moreover, the biomass produced in photosynthesis is ultimately an addition to the organic load.

Water temperature is an important factor controlling the dissolved oxygen concentration. The solubility of oxygen in water decreases with increasing temperature. At a water temperature of 5° C, for example, the maximum dissolved oxygen concentration is just under 13.0 mg/liter. At 25° C, however, the maximum concentration is only 8.3 mg/liter.

CARBON DIOXIDE AND CARBONATE EQUILIBRIA

As microbial decay of organic matter consumes oxygen, organic carbon is converted to carbon dioxide. This production of carbon dioxide is one factor controlling the equilibrium of carbon dioxide and carbonate and bicarbonate ions in water. As oxygen is required by saprophytic organisms, carbon dioxide is a vital nutrient for photosynthetic organisms. Whereas the solubility of oxygen is controlled primarily by water temperature, the occurrence of carbon dioxide is controlled by several additional factors.

The availability of carbon dioxide in water is primarily controlled by alkalinity and pH. The pH is the negative logarithm to the base 10 of the hydrogen ion concentration. Waters of extremely low pH are acidic. Alkalinity is a measure of all characteristics which tend to elevate pH. In natural waters the greatest contributors to alkalinity are the bicarbonate ion and the carbonate ion. Depending on water pH, these two species of inorganic carbon may provide an important source of carbon dioxide replenishment as it is utilized by autotrophic organisms.

The production of carbon dioxide through biodegradation does not acutely impact water quality as does the concurrent consumption of oxygen. However, the production of carbon dioxide from biodegradation plays a key role incontrolling the carbonate equilibria and alkalinity of water.

The ultimate impact of organic matter decomposition on carbon cycling in the aquatic ecosystem should be considered when evaluating organic loading.

SOURCES OF ORGANIC LOADING

Organic matter loading often occurs as a result of direct discharges such as untreated sewage and municipal or industrial wastewater effluent. These sources of organic matter pollution create the most common and most publicized oxygen depletion problems. Other sources of organic material include the indirect contribution of organic material carried by surface runoff, and direct dumping of organic material other than effluent discharges or sewage outfalls.

Inasmuch as organic material is a component of soil, the delivery of organic matter to receiving waters is part of the natural process of soil erosion and sedimentation. An acceleration in the rate of sediment delivery will also increase the rate of organic matter loading. An accleration of organic matter delivery to receiving waters may also occur if the proportion of organic sediment available to erosion is increased, even though the overall erosion rate remains the same. This may result from increasing the amount of organic matter available to erosion. Organic residue following a vegetative manipulation practice is one example of such a source. In fact, any organic material on the ground surface may be delivered to receiving waters through erosive rainfall and runoff. Of course, organic material covering the ground sufficiently to act as a mulch will reduce soil erosion and the delivery of organic sediments to receiving waters.

Some sources of organic matter pollution are neither strictly point nor non-point in nature. These types of pollutant sources might best be labeled dispersed sources. One example is the wastes of recreationists or grazing animals directly deposited in a stream channel. This type of pollution but neither is it delivered to the stream through runoff as non-point source pollution, and is not a point source such as a wastewater outfall.

APPRAISAL OF ORGANIC LOADING

Predicting the organic loading of receiving waters due to a certain management activity is impossible with present technology. Water quality fluctuations due to non-point sources of pollution cannot be attributed to specific land management activities except under controlled experimental conditions. Therefore, practical evaluation of the organic load delivered to receiving waters requires some degree of subjective judgment. In order to minimize judgmental error the wise use of pertinent water quality data, water quality models and other appropriate information should be practiced.

Several water quality parameters provide a measure of the organic material present in water. These parameters include; total organic carbon, total volatile solids, total organic energy (calories), biochemical oxygen demand (BOD) and chemical oxygen demand (COD). There are certain advantages to using each of these measures of organic load. For many water quality investigations the BOD or COD is determined since they are direct estimates of the potential amount of oxygen depletion.

To fully determine the impact of the organic load, additional water quality data is needed. The determination of dissolved oxygen concentration, temperature, alkalinity and pH is required to assess what effects the organic load may have on receiving waters.

Several models have been developed for estimation of organic matter delivery to receiving waters. Additional models will be developed in the future and refinements to the existing models will be made. The applicability of a model depends on the environmental conditions of the area under consideration. Several water quality models are referenced in the Bibliography.

Identification of organic matter pollution may be aided by information other than that provided through water quality data or models.

Inventories of aquatic macroinvertebrates may be used as indicators of oxygen depletion from organic matter pollution. Many of these organisms are relatively intolerant to low dissolved oxygen concentrations. The absence of these organisms is an indication of oxygen depletion, possibly from the biodegradation of organic matter.

Visual evidence of the delivery or potential delivery of organic matter to a receiving water is an initial indication that a pollution problem may exist. Evidence may be the actual presence of organic matter in water, or the fact that organic material within a watershed would likely be delivered to a receiving water during a runoff event. Conditions for potential delivery to a stream, for example, may be areas where fecal wastes or plants residues are located near a stream channel.

In evaluation of organic loading, the hydrologist or preferably a group of resource specialists should be utilized. All available information including water quality data, models, and indicators of pollution should be utilized in the evaluation.

The specialists should also take note of environmental conditions which may affect the impact of organic loading. Stagnant water and high water temperature, for example, affect the impact of organic matter in water. High temperature increases the rate of biodegradation and decreases oxygen solubility. Stagnant water decreases the rate of re-oxygenation. This is a typical problem in the summer when water temperatures increase and streamflow declines.

The qualification of organic matter in water is the first step in determining if a water quality problem exists. A rationale for determine in a water quality problem exists is presented in Appednix B.

INORGANIC CHEMICALS AS WATER POLLUTANTS

Several water quality problems are associated with dissolved inorganic substances. A very high concentration of dissolved solids, for example, may make water to saline for irrigation or other beneficial uses. Eutrophication is a problem which may occur in natural waters if the concentration of limiting plant nutrients is increased. Some dissolved inorganic substances may be directly toxic to plants, animals or man, if present in high concentrations. In consideration of inorganic chemicals as non-point soure pollutants, the problems of salinity, eutrophication and direct toxicity must be defined.

SALINITY

The salinity of water may have significant impacts on the agricultural, municipal, and industrial uses of water. Irrigation waters high in dissolved solids may either limit or preclude crop production. Highly saline water may also adversely impact livestock production if used for stock watering. Municipal use of highly saline water will reduce the effective life of water pipes, fixtures and water-using household appliances. Also, dissolved solids may be unacceptable in drinking water due to poor taste or adverse impacts on health.

Industrial use of saline water may result in corrosion or scale formation on boilers, pipes, and cooling systems. Various treatments may be used to decrease water salinity, but are very costly.

Fish and wildlife may also be affected by saline waters. All fish and other aquatic life have a certain given range of salinity tolerance. The impact of saline waters on terrestrial wildlife is primarily through adverse impacts on plants which provide wildlife habitat.

EUTROPHICATION

Eutrophication is a process through which natural waters are choked by the rapid and abundant growth of algae. The production of algae in water is normally held in check by one or more limiting nutrients. Theoretically, algae will continue to grow and multiply until the supply of an essential nutrient is exhausted. If the limiting nutrients are made available in abundant quantities then eutrophication will occur. The elements essential for algal growth are carbon, oxygen, hydrogen, nitrogen, phosphorus, calcium, magnesium, iron, potassium and sulphur. Additional nutrients, often called micro-nutrients, are at least beneficial to algal growth though possibly not essential.

The nutrients most often found limiting algal growth are nitrogen and phosphorus.

The availability of nutrients is an important aspect of algal growth. For example, carbon is available as molecular carbon dioxide. Many other nutrients are available in ionic form. Nitrogen is available to algae, primarily as nitrate ion. It is also present in water as nitrite, ammonia, ammonium ion, dissolved nitrogen gas, and in many organic compounds. Phosphorus is available to algae as phosphate ion.

TOXIC SUBSTANCES

Individual inorganic constituents of waste may have specific impacts on water quality. Some problems associated with saline waters, for example, are caused by a relatively high concentration of just one constituent. The laxative effect of saline water, for example, is caused primarily by magnesium sulfate and sodium sulfate. Though several constituents may create only nuisance problems, others may be directly toxic if present in sufficient concentration.

There are many potentially toxic inorganic chemicals. Some of these toxic substances, including nitrate and several of the heavy metals, may result from non-point source pollution.

Nitrate may be reduced to nitrite in the gastrointestinal tract of some mammals. When nitrite reaches the bloodstream it reacts with hemoglobin, impairing oxygen transport. Severe nitrite poisoning may be lethal. Human infants and ruminant animals are particularly susceptible to nitrite poisoning.

Several heavy metals are toxic at relatively low concentrations. Several of these pollutants including lead, cadmium and mercury are generated primarily from industrial discharges or mine drainage. Other heavy metals, however, may occur at dangerously high concentrations in natural waters. For example, the high concentration of selenium in natural waters is a problem, particularly in some arid regions. Selenium is toxic to both humans and animals. "Alkali disease" and "blind stagggers" of cattle are reactions to selenium poisoning.

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SOURCES OF INORGANIC CHEMICALS IN WATER

Inorganic chemicals in water are naturally derived from rainfall, throughfall, the leachates of organic residues and through the drainage of soils and aquifers. The delivery of chemical pollutants to receiving waters may be accelerated by runoff from mining wastes, concentrated fecal material, generally saline soils, or soils high in specific substances.

Fecal wastes contain high quantities of nitrogen and phosphorus. Problems of excessive plant nutrients or nitrate contamination may result from concentrated animal or human waste. The congregation of grazing livestock or recreationists near water supplies is a potential source of these pollutants.

The levels of plant nutrients and other salts in water may be affected by vegetative management. Burning or cutting of vegetation on a watershed, for example, releases increased quantities of plant nutrients. These nutrients are available to runoff and leaching until they are again utilized by vegetative regrowth.

Many inorganic substances are transmitted to receiving waters while chemically bound to sediment particles. Therefore, accelerated erosion and runoff, in general, may contribute to the problems of salinity, nutrients, and toxic materials in water.

APPRAISAL OF INORGANIC CHEMICAL IN WATER

The precise impact of land use activities on water is difficult to assess. The appraisal of the water quality impacts of a specific management activity requires wise use of all available information. The judgement of hydrologists and other resource specialists should be used to interpret water quality data, water quality models, and other useful information. Through this procedure, a reasonable evaluation of salinity, eutrophication and toxic substances can be completed.

Inorganic substances in water are measured through several methods of analysis. Salinity is measured by determination of total dissolved solids. Electrical conductivity readings also provide an indication of water salinity. Either one of these parameters is very useful information when assessing salinity problems.

Determination of the quantity of possible limiting nutrients, such as nitrogen or phosphorus, is needed to evaluate eutrophication potential. Nitrate and phosphate are the forms of nitrogen and phosphorus most readily available to algae. Knowledge of these forms is particularly helpful.

Evaluation of the possible toxicity of various substances requires the determination of each suspected toxic chemical.

Several models have been developed for predicting the non-point source contribution of nutrients, salts, and heavy metals to receiving waters. Improvements in predicting pollutant loadings will probably be developed in the future. The usefulness of a specific water quality model may vary from area to area. A hydrologist will be able to determine the applicability of a specific water quality model. Several water quality models are referenced in the Bibliography.

Several visual indicators of eutrophication, salinity and toxic materials can be made without water quality data or loading functions. Algal blooms, for example, occur periodically in waters with excessive quantities of plant nutrients. Excessively saline waters may be evidenced by salt precipitates along stream banks and through the decline of riparian vegetation intolerant to salinity. Sterile waters, devoid of all aquatic life, may indicate the presence of toxic chemicals. Although visual indicators are useful, a water quality problem may exist even when "symptoms" are not readily apparent.

PESTICIDES AS A WATER POLLUTANT

Pesticides play an important role in modern land management practices. "Pesticide" is a general term which includes herbicides, fungicides, rodenticides, insecticides, nematicides, molluscicides and other similar chemicals. Insecticides, nematicides, molluscicides and rodenticides are used to reduce populations of pests that threaten agricultural crops and forests. Herbicides and fungicides are used to eliminate undesirable vegetation from forest plantations, range allotments, road right-of-ways, campgrounds, and water bodies.

SOURCES OF PESTICIDES

This discussion will focus on the uses of pesticides in range and recreation management. Range managers use herbicides such as 2,4-D and 2,4,5-T to eliminate undesirable types of forage that are competing with more palatable species. Recreation managers can improve recreation quality by using pesticides for a variety of purposes such as spraying insecticides on stagnent water supplies to reduce mosquito populations or by adding algaecides to reservoirs to rid them of undesirable aquatic plants. Pesticides may be present in ground and surface waters as the result of direct delivery such as; 1) direct application for aquatic insect or aquatic plant control, 2) drift from adjacent sprayed areas, 3) accidental spills, or 4) discharge of wastes from cleanup operations. Pesticides can also be indirectly delivered to water sources by; 1) overland flow of residues during intense rainstorms, 2) leaching of residues during percolation of rainfall and 3) binding to sediments and traveling via erosional processes.

Although beneficial, the widespread use of these chemicals cannot be condoned without adequate consideration of their possible impact on non-target organisms such as fish and wildlife and on environmental quality as a whole. The U.S. Fish and Wildlife Service began monitoring the effects of DDT on the environment in the 1940's. Drift from sprayed areas into adjacent water sources killed fish and reduced bird and insect populations (Walker, 1977). This prompted investigations of physical and chemical properties of pesticides, the transport and fate of pesticide residues and breakdown products and the synergistic toxicity of some combinations of pesticides.

Some pesticides such as DDT, Aldrin, Dieldrin and Chlordane were found to be persistent and mobile to such an extent that residues of these banned pesticides will persist for many years even though use of these pesticides has stopped. Persistence alone is not a water quality problem but the effects of persistent pesticides on non-target organisms can be a problem. Long term, low level exposure to some pesticides by non-target organisms has resulted in carcinogenic and teratogenic responses. Pesticide residues are accumulated in living systems and recycled in much the same ways that certain elements essential for life are recycled. Organisms at higher trophic levels (i.e., at higher levels in the food chain) accumulate the

residues consumed by their prey. This process of biological accumulation results in the concentration of residues in higher animals. The persistence of pesticides in surface water poses potential hazard not only to wildlife but to cultivated crops as well. Hodgson (1966) reported that irrigation water containing concentrations of the herbicide picloram as low as 0.1 ppm reduced the yield of sugar beets (Soil Science Society of America, 1974). Some pesticides when used in combination with each other can have a synergistic or an antagonistic effect. The biological significance of various levels of use and of the effects of combining pesticides has not been well documented.

APPRAISAL OF PESTICIDES

As with other water contaminants, pesticides become a water pollution problem when their presence adversely affects beneficial uses of water. The magnitude of hazard to beneficial uses of water depends on the toxicity of the chemical and the likelihood that non-target organisms will be exposed to toxic doses of the chemical.

Adverse effects on water quality may result from: 1) the pesticide itself or solvent carriers used in commercial formulations, 2) byproducts of the pesticide and 3) impurities in the manufactured products.

As with other water contaminants, mere presence of the pesticide does not mean a water quality problem exists. The hydrologist must determine, with the assistance of an interdisciplinary team, whether the pesticide, at the level present, is adversely affecting beneficial uses. The hydrologist can investigate a suspected pesticide pollution problem by testing for the presence of the pesticide, by predicting the level of pesticides present using loading functions or by subjective evaluation of evidence suggesting pesticide presence.

Testing for the presence of pesticides can be done during or immediately after the spray operation and at regular intervals for an indefinite period of time necessary to identify the peak levels. Tests during the spray operation consist of placing spray sensitive cards along water courses to detect drift from adjacent sprayed areas. After spraying, water samples can be taken in the area that was treated and at various locations downstream. The preferred sampling method is depth-integrated sampling although grab samples may suffice in rapidly flowing streams. Sampling can be repeated weekly or monthly thereafter. Samples are analyzed by a commercial laboratory. Gas-paper or thin layer chromotography are the most sensitive and most widely used methods. The Federal Working Group on Pest Management (1975) discusses currently accepted methods for analyzing pesticide residues.

The results of such a sampling program should provide data on the initial pesticide concentration, the effect of dilution by varying volumes of water downstream (on pesticide concentration) and breakdown rates of pesticides.

However reliable these results are, knowledge of pesticide levels in water may not be the best indicator of environmental contamination by pesticides. Pesticide residues can bind to stream bottom sediments and remain trapped until high flows again mobilize them. Core sampling or dredge sampling of bottom materials may detach higher concentrations of pesticides than in the overlying water. Testing of organisms exposed to pesticides can sometime be a better indicator of environmental contamination than sampling the water and sediments alone. Biota are exposed to pesticides by direct absorbtion and by biological accumulation through the food chain. Pesticides accumulate in the lipids of organisms and even low concentrations at low trophic levels can have toxic effects on organisms at higher trophic levels. Since the motivation behind testing for all water pollutants is to detect levels of contaminants which may have adverse impacts on the biota, testing for adverse impacts on the biota can assist hydrologists in determining harmful levels of pesticides in water. Tissue samples or blood samples of organisms at higher trophic levels, such as fish and birds, are analyzed for pesticide residues (Monitoring Panel of the Federal Working Group on Pest Management, 1974).

Loading functions are sometimes used to estimate nonpoint pollution emmisions with a minimum of field measurement. The EPA publication "Loading Functions for Assessment of Water Pollution for Nonpoint Sources" (1976) discusses loading functions used for predicting pesticide loads. The loading functions presented are limited to use in estimating cumulative pesticide loads for agricultural lands where pesticide spraying activities have been conducted over a long period of time on large areas (e.g., states, major basins). The loading functions are not sufficiently sensitive to predict loads for localized areas or to predict peak loads which occur from pesticide use at or before times of high runoff.

If data documenting pesticide presence are not available and if loading functions cannot adequately predict pesticide loads, the hyrologist must resort to professional judgement in evaluating potential pesticide pollution problems. Knowlege that pesticide application has occurred, expecially if there is any reason to suspect it has been done incorrectly, should warrant investigation by the hydrologist.

SOLID WASTES

Range and recreation management activities generate solid wastes which consist of litter, trash and sewage. These solid wastes are usually dispersed in location and should not be confused with solid waste disposal sites and their associated problems. A separate component of the BLM's agreement with the State Water Resources Board, requires the BLM to develop a document which addresses solid waste disposal practices on public lands.

SOURCES OF SOLID WASTES

Solid wastes generated by range and recreation management activities can be potential water contaminants. Some of the constituents of solid wastes, such as associated bacteria, nutrients, and organic compounds, often have more serious water quality impacts than does the physical presence of the solid wastes. The physical presence of solid wastes and minimal amounts of associated metals [1/] can adversely impact water quality. Wildlife and fish have been known to swallow shiny items such as beverage can pop-tops. Litter and trash can be physically restraining to fish mobility. Metals slowly decompose, are recycled through the biota, and accumulate in the tissues of fish and wildlife.

Solid wastes can be directly or indirectly delivered to water sources. Litter, trash and sewage can be directly deposited into surface water supplies or the decomposition by-products of the wastes can reach ground and surface waters through leaching.

APPRAISAL OF SOLID WASTES

The presence of solid wastes does not necessarily constitute a water quality problem. Solid wastes become a water quality problem when their presence adversely affects the beneficial uses of a particular water source. The hydrologist, with the assistance of an interdisciplinary team, must determine if the solid wastes and associated constituents are adversely impacting beneficial uses of water. The hydrologist can investigate a suspected pollution problem by testing for the presence of harmful constituents of solid wastes, by estimating the concentrations of those constituents using loading functions and/or by subjective evaluation of the extent of solid waste pollution. Tests to determine concentrations of constituents and loading functions to estimate concentrations of those constituents are presented in the sections in this Appendix which discuss those pollutants.

If data documenting the presence of harmful solid waste constituents is not available and if loading functions have not been used to estimate concentrations of those constituents, the hydrologist must resort solely to professional judgement in evaluating potential solid waste pollution problems. Further investigation is warrented if solid wastes or evidence of harmful constituents of solid wastes (guidelines presented in the sections which discuss those pollutants) is present.

1/ Concentrations of metals contributed to water by solid wastes are probably minimal compared to other sources such as acid mine drainage and industrial discharges.

APPENDIX B

WATER QUALITY

PROBLEM DETERMINATION

This appendix will present a rationale for determining if a water quality problem exists. The essence of this rationale is the identification of several categories of information which are basic elements to be considered in the problem determination process. Included among these categories is water quality information which relates to various potential water pollutants. The kind of information which can be utilized for specific water quality constituents is discussed in Appendix A. Other elements of the problem determination process include, 1) an inventory of all beneficial uses of the water resource, 2) pertinent water quality standards and criteria, 3) water quantity data, and 4) watershed characteristics. The relative importance of each of these elements will vary, depending on the situation. The final phase of water quality problem determination is a resource management decision. Under this phase problems may be rated, based on severity and on the effectiveness with which best managment practices could improve water quality. This scheme of problem rating will provide an automatic mechanism of prioritization for implementation of best management practices.

INVENTORY OF BENEFICIAL USES

The identification of the beneficial uses of a water resource is essential to the specification of water quality needs and the identification of water quality problems. The quality of water needed for one beneficial use may be very different from that required for another. The standards for drinking water, for example, are generally much higher than those for agricultural and industrial uses. The California State Water Resources Control Board has identified beneficial uses of California's water supplies. The beneficial uses recognized by the board include the following:

1. Municipal and Domestic Supply -- Includes usual uses in community or military water systems and domestic uses from individual water supply systems.

2. Agricultural Supply -- Includes crop, orchard, and pasture irrigation; stock watering; and support of farming and ranching operations.

3. Industrial Service Supply -- Includes uses which do not depend primarily on water quality, such as mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization.

4. Industrial Process Supply -- Includes process water supply and all uses related to the manufacturing of products.

5. Groundwater Recharge -- Natural or artificial recharge for future extraction for beneficial uses and to maintain salt balance or halt saltwater intrusion into freshwater aquifers.

6. Freshwater Replenishment -- Provides a source of freshwater for replenishment of inland lakes and streams of varying salinities.

7. Navigation -- Includes commercial and naval shipping.

8. Hydropower Generation -- Used for hydropower generation.

9. Water Contact Recreation -- Includes all recreational uses involving actual body contact with water, such as swimming, wading, waterskiing, skin diving, surfing, sport fishing, uses in therapeutic spas, and other uses where ingestion of water is reasonably possible.

10. Non-Contact Water Recreation -- Recreational uses which involve the presence of water but do not require contact with water, such as picnicking, sunbathing, hiking, beachcombing, camping, pleasure boating, tidepool and marine life study, hunting, and esthetic enjoyment in conjunction with the above activities as well as sightseeing.

11. Ocean Commercial and Sport Fishing -- The commercial collection of various types of fish and shellfish, including those taken for bait purposes, and sport fishing in ocean, bays, estuaries, and similar nonfreshwater areas.

12. Warm Freshwater Habitat -- Provides a warm-water habitat to sustain aquatic resources associated with a warm-water environment.

13. Cold Freshwater Habitat -- Provides a cold-water habitat to sustain aquatic resources associated with cold-water environment.

14. Preservation of Areas of Special Biological Significance -- Includes marine life refuges, ecological reserves, and designated areas of special biological significance, such as areas where kelp propagation and maintenance is a feature of the marine environment requiring special protection.

15. Saline Water Habitat -- Provides an inland saline water habitat for aquatic and wildlife resource.

16. Wildlife Habitat -- Provides a water supply and vegetative habitat for the maintenance of wildlife.

17. Preservation of Rare and Endangered Species -- Provides an aquatic habitat necessary, at least in part, for the survival of certain species established as being rare and endangered species.

18. Marine Habitat -- Provides for the preservation of the marine ecosystem including the propagation and sustenance of fish, shellfish, marine mammals, waterfowl, and vegetation such as kelp.

19. Fish Migration -- Provides a migration route and temporary aquatic environment for anadromous or other fish species.

20. Fish Spawning -- Proides a high quality aquatic habitat especially suitable for fish spawning.

21. Shellfish Harvesting -- The collection of shellfish such as clams, oysters, abalone, shrimp, crab, and lobster for either commercial or sport purposes.

These beneficial uses have been categorized by surface and groundwater supplies for various hydrologic areas within each of nine regions. The identification of beneficial uses and other water quality planning information appears in the Water Quality Control Plan Report of each region.

For a particular hydrologic area the Bureau of Land Management, or any other public or private entity, may recognize beneficial uses in addition to those identified by the state. Such uses may include potable water, stock watering, wildlife habitat and recreation. These uses should be included in the comprehensive inventory of beneficial uses.

WATER QUALITY STANDARDS AND CRITERIA

In order to maintain a beneficial use, there may be specific water quality criteria which must be met. Some criteria, particularly water quality criteria for irrigation or domestic use, are based on scientific knowledge. Criteria for other aspects of water quality, such as aesthetics, are developed more subjectively.

In the interest of identifying quality criteria for several beneficial uses of water, the Wyoming Office of the Bureau of Land Management has compiled a Table of Standards and Criteria (Table 3-1). These standards and criteria are taken from the following sources:

a. Water Quality Criteria 1977, a Report of the Committee on Water Quality Criteria, Environmental Studies Board, National Academy of Sciences, National Academy of Engineering, Washington, D.C., 1972.

b. Quality Criteria for Water, U.S. Environmental Protection Agency, July 1976.

c. Water Quality Criteria, Second Edition, the Resources Agency of California State Water Quality Control Board, Publication No. 3-A, 1963.

d. Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, 1968.

The source of each standard or criteria in the Table is identified by the corresponding subletter.

The Primary Drinking Water Standards are standards which represent the maximum allowable contaminant levels as promulgated in the National Interim Drinking Water Standards. A maximum contaminant level is defined as the maximum permissable level of a contaminant in water which is delivered to the free-flowing outlet of the ultimate use a public water system. These standards are enforceable through either the Environmental Protection Agency or individual states which have accepted primacy.

Secondary Drinking Water Criteria are those criteria promulgated by EPA (Federal Register, March 31, 1977) which deal with the aesthetic qualities of drinking water. The contaminants identified in this column may not have a significant direct impact on the health of consumers, but their presence in excessive quantities may discourage the utilization of a drinking water supply by the public. Secondary regulations are not federally enforceable and are intended as guidelines.

There are several other sources of published water quality standards and criteria. Among these are the Water Quality Control Reports for California's Regional Water Quality Control Boards. The standards in these reports are the most comprehensive criteria related directly to the beneficial uses of California's water resources. The water quality objectives, as stated in each of the Water Control Plan Reports, are very significant since they are, in effect, enforceable standards. The reports identify water quality objectives set for specific constituents for the beneficial uses within individual hydrologic areas.

In addition to the support of water quality objectives, California law provides for a policy of non-degradation. Under this policy waters of high quality must be maintained except as otherwise provided in California's water quality regulations. As expressed in Executive Order 12088, the Bureau of Land Management is obligated to comply with the State's water quality objectives,including the policy of non-degredation.

The Bureau of Land Management may develop water quality management objectives apart from those supported by the state. It may be desirable, for example, to develop standards for water supplies used to water livestock.

The support of both California and Bureau of Land Management water quality objectives will help maintain the beneficial uses of our water resources.

TABLE B-1 WATER QUALITY STANDARDS AND CRITERIA*

Indicator	Primary Drinking Water Standards	Secondary Drinking Water Criteria	Cropland Irrigation	Fisheries and Freshwater Acquatic Life	Wildlife and Livestock	Primary Body Contact Recreation
Alkalinity as $CaCO_3$			<600b	>20b Except where natural concentrations are less	<170c	
Aluminum			1.0d			
Ammonia (Un-ionized as N)				.02b		
Arsenic	.05		.2a	1.0c	1.0c	
Bacteria						
Fecal Coliform			<1000			200/100ml
Fecal Coliform			100mla			Log Mean b
Barium	1.0			5.0c		
Beryllium			.5b	Soft Water .011 Hard Water 1.1b		
Boron			.75d		5.0a	

* All concentration is mg/l unless otherwise specified.

TABLE B-1 (cont.) WATER QUALITY STANDARDS AND CRITERIA*

Indicator	Primary Drinking Water Standards	Secondary Drinking Water Criteria	Cropland Irrigation	Fisheries and Freshwater Acquatic Life	Wildlife and Livestock	Primary Body Contact Recreation
Cadmium	.01		.005d	Soft Water .0004 Hard Water[b] .0012		
Chloride		250	100c		1500c	
Chronium	.05		5.0d	.1b	1.0a	
Copper		1.0	.2d	.02c	.5a	
Cyanide			.005b			
Floating Solids						
Fluoride	At Air Temp. of (°C.) / Fluoride Level Allowed 12.0 & below / 2.4 12.1-14.6 / 2.2 14.7-17.6 / 2.0 17.7-21.4 / 1.8 21.5-26.2 / 1.6 26.3-32.5 / 1.4		10.0c	1.5c	1.0c	
Gases, total dissolved				110%		

TABLE B-1 (cont.) WATER QUALITY STANDARDS AND CRITERIA*

Indicator	Primary Drinking Water Standards	Secondary Drinking Water Criteria	Cropland Irrigation	Fisheries and Freshwater Acquatic Life	Wildlife and Livestock	Primary Body Contact Recreation
Iron		.3		1.0b		
Lead	.05		5.0a	.05c	.1a	
Lithium			2.5a			
Manganese		.05	.2a	1.0c		
Mercury	002			.00005b	.01a	
Molybdenum			.01a			
Nickel			.2a			
Nitrate as N	10					
Nitrite as N					10a	
Nitrate + Nitrate N					100a	
Oil and Grease						Virtually free
Oxygen, Dissolved				≥5b		
Phenols			50c	.001b	1000c	
ph		6.5-8.5	4.5-9.0d	6.5-9.0b	7.0-9.2a	6.5-8.3d

TABLE B-1 (cont.) WATER QUALITY STANDARDS AND CRITERIA*

Indicator	Primary Drinking Water Standards	Secondary Drinking Water Criteria	Cropland Irrigation	Fisheries and Freshwater Acquatic Life	Wildlife and Livestock	Primary Body Contact Recreation
Phosphate (P)**						
Stream				.050b		.050b
Lake				.025b		.025b
Radiation						
Gross Alpha Particle Activity (Includes Radium-226, but Excluding Radon and Uranium)	15 pCi/l					
Radium 226 & 228	5 pCi/l					
Strontium 90	8 pCi/l					
Selenium	.01		.02a		.05a	
Silver	.05					
Solids Settleable						
Solids Dissovled		500	700c	2000c	2500c	
Sulfate		250	200c		500c	

** Criteria are to prevent cultural eutrophication which is esthetically unpleasing and detrimental to fish.

TABLE B-1 (cont.) WATER QUALITY STANDARDS AND CRITERIA*

Indicator	Primary Drinking Water Standards	Secondary Drinking Water Criteria	Cropland Irrigation	Fisheries and Freshwater Acquatic Life	Wildlife and Livestock	Primary Body Contact Recreation
Sulfide H_2S				.002b		
Temperature						
Max. ^{o}C (^{o}F)						30 (85)d
Min. ^{o}C (^{o}F)						15 (59)
Vanadium			.1a		.1a	.1a
Zinc		5.0	2.0a	.05c	25a	

WATER QUANTITY DATA

The consideration of water quantity data is important when assessing non-point source water pollution. Even when expressed water quality objectives are stated, and water quality data is available, the contribution of a non-point source may be inseparable from other sources. In these situations the analysis of streamflows may help define the various contributing sources. Water quality problems, for example, may exist in a stream, where potential sources of non-point pollution are located on one or more tributary watersheds.

The contribution of the non-point sources to water quality problems on a stream's main stem may be analyzed through the determination of each tributary's addition to total main stem streamflow. Where streamflow data is lacking, rainfall - runoff models may be used to generate streamflow data.

Where seasonal water quality problems occur, the seasonal fluctuations of water flow may be an important consideration in analyzing water quality problems. Both oxygen depletion and excessive algae growth are often found to occur seasonally during periods of low flow. The non-point sources of pollution within ephemeral drainages may be significant during periods of high runoff but seldom contribute to pollution problems associated with low flows.

Rainfall data alone may be important in determining water quality problems. Rainfall intensity and total energy strongly influence the delivery rate of many non-point source pollutants to receiving waters. These rainfall characterisitics are utilized as independent variables in several non-point source pollutant loading functions.

The knowledge of various aspects of water quantity, coupled with water quality data, can greatly aid in assessing of the impact of non-point source pollutants.

WATERSHED CHARACTERISTICS

The knowledge of certain watershed charateristics may help identify the potential generation of non-point source pollution from a particular drainage.

The soil charateristics and geology of a watershed, for example, strongly influence the hydrologic response of the watershed as well as the rate of sediment production and the chemical quality of the streamflow draining the watershed.

Knowledge of the distribution and density of plant cover is also an important factor in determing the sediment production and hydrologic response of a watershed.

The generalized knowledge of the various characteristics of different watersheds may provide information to determine what background levels of specific pollutants can be expected.

Various watershed characteristics including area, length, hypsometric ratios and relief-length ratios are used to help define the hydrologic characteristics of different drainages. These descriptive measures of the watershed, combined with rainfall and streamflow data and with measures of land management disturbance, may be used in descriptive models of non-point source pollutant loading.

THE PROBLEM DETERMINATION AND PRIORITIZATION DECISION

The identification of a water quality problem must often be a judgment. Adequate information for making a categorical assessment may be lacking. Water quality data from direct monitoring of non-point source pollution is scarce. The utility of general water quality data is confounded by the many interactions which affect the delivery of non-point source pollution to receiving waters.

Future monitoring of non-point source pollution will help insure better assessments of the impacts of managment activities on water quality. For the most part, however, this type of data is now lacking, and will probably be limited in the future.

Where this direct data is unavailable, the determination of water quality problems must, to a certain extent, be a subjective decision. The careful consideration of water quality information, water quantity relationships and watershed characteristics, however, will help delineate the effects of management activities, and aid in making a sound decision. The identification of water quality problems will also be facilitated through consideration of beneficial uses, and water quality criteria.

The final decision must be made under obligations to comply with water quality management objectives. For critical situations it may be prudent to be conservative in problem determination decisions, at least until water quality monitoring yields more definitive information.

Ideally the determination of water quality problems will be accompanied by a prioritization of problems to be addressed through implementation of best management practices. The prioritization should be based on which problems are most critical, and on the margin of water quality improvement which can be expected form a given level of implementation expenditure.

GLOSSARY

Allotment Management Plan (AMP): A written plan for the management of livestock grazing designed to attain prescribed goals for each grazing allotment (a parcel of public lands assigned to a grazing lessee). Each AMPs establish grazing use patterns or systems to stimulate the growth of the desired vegetation.

Animal Unit Month (AUM): A measure of forage or feed required to maintain one cow or 5 sheep one month. The AUM is primarily used in measuring the amount of forage on public lands.

Best Management Guideline (BMG): Initial management guideline which becomes a Best Management Practice (BMPs) when determined by the Bureau to be the best means of preventing or reducing the amount of pollution generated by non-point sources to a level compatible with water quality goals.

Best Management Guideline Improvement Flowchart (BMGIF): Describes a continuous development process for the determination of, and improvement of Best Management Practices.

Best Management Practice (BMP): A practice, or combination of practices, that is determined by a state (or designated area wide planning agency) after problem assessment examination of alternative practices and appropriate public participation to be the most effective, practicable (including technological, economic and institutional considerations) means of preventing or reducing the amount of pollution generated by non-point source to a level compatible with water goals.

Clean Water Act (Public Law 95-217): Amends PL 92-500, the Federal Water Pollution Control Act Amendments of 1972. The Act provides additional funding for 208 planning and establishes a financial assistance program.

Environmental Protection Agency (EPA): Federal regulatory agency responsible for protecting environmental quality throughout the nation. Responsible under the Federal Water Pollution Control Act Amendments of 1972 and the Clean Water Act of 1977 for administration of 208 planning in both designated and nondesignated areas on a nation wide basis.

Environmental Statement (ES): A document prepared in response to the National Environmental Policy Act of 1969. The ES assesses the impacts of a proposed action on the quality of the human environment. It also identifies mitigating measures that can be employed to reduce adverse impacts. The ES is a tool that decision-makers use to weigh the environmental consequences of a proposed action.

Federal Compliance with Pollution Control Standards (Executive Order 12088): Requires Federal agencies to comply with applicable pollution control standards. Each agency must submit to the Director of the Office of Management and Budget, through the Administrator of the EPA, on annual plan for the control of environmental pollution. The head of each agency must ensure that sufficient funds for compliance with pollution control standards be requested in the agency budget.

Federal Land Policy and Management Act of 1976 (FLPMA): A comprehensive federal law combining and consolidating many archaic and often conflicting federal land management laws. It is the first clear cut mandate Congress has ever given to the Bureau of Land Management for managing the 473 million acres of public lands under its jurisdiction. Also called the BLM Organic Act.

Federal Water Pollution Control Act Amendments of 1972 (PL 92-500): Legislation which seeks to "restore and maintain the biological integrity of the Nation's waters", and sets a goal that all waters shall be "swimmable and fishable" by 1983. Section 208 of the act requires states to conduct planning for ways to implement point and non-point source water pollution controls.

Grazing Systems: These may include one or a combination of the following systems:

1. Season-long Grazing: Grazing during any specified season.

2. Deferred Grazing: A delay of grazing for a specific period of time during the growing season.

3. Rotation Grazing: Grazing one pasture, then another, allowing regrowth of the vegetation between periods of grazing.

4. Deferred-rotation Grazing: Combines the above two grazing systems. This includes alternative pastures to delay grazing on a portion of the range until a specific plant growth stage is reached. With this system, the entire range is used at some time during the grazing season.

5. Rest-rotation Grazing: This allows rest from grazing at suitable intervals to counteract the harmful effects of selective grazing. Under this system of management, a pasture or unit of range is deferred or rested from use after a season of grazing. This rest is designed to: (a) give plants the opportunity to make and store food - to recover vigor; (b) allow seed to ripen; (c) let seedlings become established; and (d) allow litter to accumulate on the soil surface.

Groundwater Recharge: Movement of water from the earth's surface to underground bodies of water (aquifers).

Habitat Management Plan (HMP): A BLM activity plan designed for a specific area to achieve maximum wildlife production.

Land Exchange: Trading of public lands (with or without subsurface rights) for lands in other ownerships which have value for public use, management and enjoyment. An exchange may be for the benefit of other federal agencies so well as BLM.

Management Framework Plan (MFP): A planning decision document which establishes, for a given planning area, land use allocations, coordination guidelines for multiple use and management objectives to be achieved for each class of land use or protection. It is the Bureau's Land Use Plan. It is prepared in three steps: Step One - Resource Recommendations; Step Two - Impact Analysis and Alternative Development; and Step Three - Decisionmaking.

Multiple Use Management: A philosophy designed to enable public lands to be managed for as many uses simultaneously as practical. This philosophy recognizes diverse needs of the public and tries to relate these needs to the various resource values on the land.

National Environmental Policy Act of 1969 (NEPA): This act requires that federal agencies consider and document the environmental impact of proposed legislation or actions that would have a signficant effect on the quality of the human environment. Regulations promulgated by the Council on Environmental Quality require environmental statements to comply with this law.

Off-Road Vehicle: Any vehicle capable of, or designed for travel on or immediately over land, water, or other natural terrain, deriving motive power from any sources other than muscle, excluding: (1) any non-amphibious registered motorboat; (2) any military, fire, emergency, law enforcement or other government vehicle while being used for official or emergency purposes; (3) any vehicle whose use is expressly authorized on public land.

Planning Area: One or more complete planning units for which a land use plan is to be prepared.

Planning Unit: A portion of a Bureau of Land Management district used for assembling resource inventory data. For each planning unit the district manager prepares a Unit Resource Analysis.

Problem Criteria Flowchart (PCF): Describes a process used to determine if a water quality problem exists when present management practices are applied to a particular situation.

Reclamation of Mined Land: The process of returning mined lands to a stable condition and form consistent with their pre-mining productivity and use or other approved post-mining land use. Also called rehabilitation.

Recreation Activity Plan (RAP): Establishes how the various guidelines, management objectives and planning decisions in the Resource Management Plan are to be carried out.

Recreation and Public Purposes Act (R&PP): An act passed by Congress on June 14, 1926, which allows for the disposal of public lands to certian governmental agencies or other qualified

Regional Water Quality Control Board (RWQCB): A regional agency, with boundaries based on watershed basins, which administers state and federal water quality control programs in California within its region. Responsible for preparation of 208 plans in the non-designated areas of California.

Resource Management Plan (RMP): Provides goals and objectives for recreation and sets policy for recreation management within each of the six BLM districts.

Riparian Habitat: Natural wildlife abode situated on or pertaining to the bank of a river, stream or other body of water.

Sanitary Landfills: Land used for disposing of solid municipal or industrial waste such as garbage, paper, sludge, cans, glass or other disposal items. Disposal is accomplished through placement in trenches and covered with soil. Landfills may be located on land where additional filling is needed prior to converting the land to other uses.

State Water Resources Control Board (SWRCB): State agency which administers California's program for water quality control. Responsible for administration and coordination of 208 planning in non-designated areas of California.

Stocking Rate: In range management, the area of land alloted to each animal unit for the grazable period of the year expressed in acres per animal unit month.

Unit Resource Analysis (URA): A basic source of information on the land and its resources, consisting of:

Base Map
Physical Profile
Resource Inventory Summaries
Resource potential and capability

of the land to fill the public's needs for these activities: lands, minerals, recreation, wildlife, watershed, forest products and range management.

Visitor Use Only (VUO): One visitor use day is twelve visitor hours which may be aggregated continuously, intermittently, or simultaneously by one or more persons and is a figure to determine the use of a recreation facility.

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APPENDIX C

DETAILED DESCRIPTION OF

BMP DEVELOPMENT PROCESS

(FLOWCHARTS)

Problem Criteria Considerations

The intent of this phase of BMP development is to determine if a water-quality problem exists when present management practices are applied.

To begin, a management activity is considered (see Figure 4-2 , M-1); if the activity is presently being conducted, then all known or possible constituents emanating from the activity are considered (M-3).

The constituents from M-3 are quantified by the best possible means available (VM-1), which include: water-quality data representative of the stream under consideration; use of state-of-the-art models and/or loading functions; or "best professional judgment" (see Appendix A for a detailed discussion of each). Procedures used in VM-1 will be continually re-evaluated and updated/improved as experience with BMPs grows. Input to VM-1 will also come from annual technical workshops (M-4).

Once the water constituents have been quantified (VM-1), the method to determine if pollution exists (VM-2) is formulated and this determination is made (M-5). Two courses of action are now open, depending on whether or not pollution is determined to exist. If there is no pollution, then consideration is given to the possibility of implementing a less stringent management practice (M-6).

If M-6 is the least stringent practice that can be implemented without resulting in water-quality problems, it becomes a "best management practice (BMP)." If it is not the least stringent, the process is repeated until the least stringent practice is found (M-7). The practice is then documented for use in development of other BMPs (M-26).

If pollution is determined to exist as a result of implementing the original management practice, its severity (high, medium, low) is determined. The process now moves from defining problem criteria to determining how the management practice can be improved and water-quality problems abated.

Best Management Guidlines Improvement

Development and improvement of best management guidlines (BMG) is a continuing process. Through the periodic workshops, ideas will be exchanged and new material included in the variable modules. As new data and information are gained from the "best management guidelines improvement" process, they will be recycled through the problem criteria consideration phase to enable better decisions on best management practices to be made throughout the entire process.

All initial management actions will be considered "best management guidelines" until they are determined, by BLM, to be effective means of preventing or reducing nonpoint source polution to levels compatible with water-quality goals. When this determination is made, the management practice becomes a best management practice (BMP). The basis of this designation includes: (1) problem assessment; (2) examination of alternative practices; and (3) public participation.

The following flowchart (Figure 4-3) outlines the process for development of best management practices from initial management actions.

The decision to consider an initial management activity as a BMG (VM-4) is based on best professional judgment, on-site investigations, and information gained in the problem-criteria process. The best management guideline is applied (M-15) and effects monitored (M-16). Whether or not a water-quality problem persists (M-17) is determined by applying the original criteria (VM-2). Where problems do persist, successively more stringent practices are applied (M-19) and monitored (M-20) until the problem is abated. The last effective practice then becomes the BMP (M-25) if it is determined to be a feasible practice.

When this most stringent effective practice is determined to be infeasible (for economic or practical reasons), the previous practice becomes the BMP, even though the water-quality problem may persist. Four options then remain: (1) water-quality goals may be made less stringent; (2) beneficial uses may be changed to fit the actual situation; (3) both goals and uses may be changed; or (4) it may be decided to live with the water-quality problem. It may be possible to change the water-quality goals or beneficial uses to eliminate situations which are "problems" only because the aplicable standards are unrealistic. However, any such changes must be coordinated with the State Water REsources Control Board and appropriate regional board.

Once the BMP has been identified, the entire process, including appropriate rationale for decisions, is documented for future use (M-26).

When an initial management activity is applied and no water-quality problems exist, the manger has the option, as under the problem criteria consideration phase, to consider implementating less stringent activities (M-27) until the threshold has been reached. The process here would flow in the same manner as in the comparable situation in the previous phase. The resulting least stringent practice becomes the BMP and is documented. Relaistically, if no problem were found under current practices, the area would not undergo further examination due to lack of adequate manpower and funding.

Once they are documented, the BMPs are incroporated into District activity plans. Of course, if the BMP applied required on-the-ground structure, etc., the action would follow the NEPA process.

Development of BMPs is intended to be a continuing process--the BMPs will be refined and updated periodically as knowledge is gained and technology changes.

Future Development

Periodic workshops and meetings will be held, attended by District Office hydrologists, other affected resource specialists, and the public (M-24). These sessions will take place at least annually and will be coordinated by the BLM State Office Air and Water Quality Specialist and/or the BLM State Office Hydrologist.

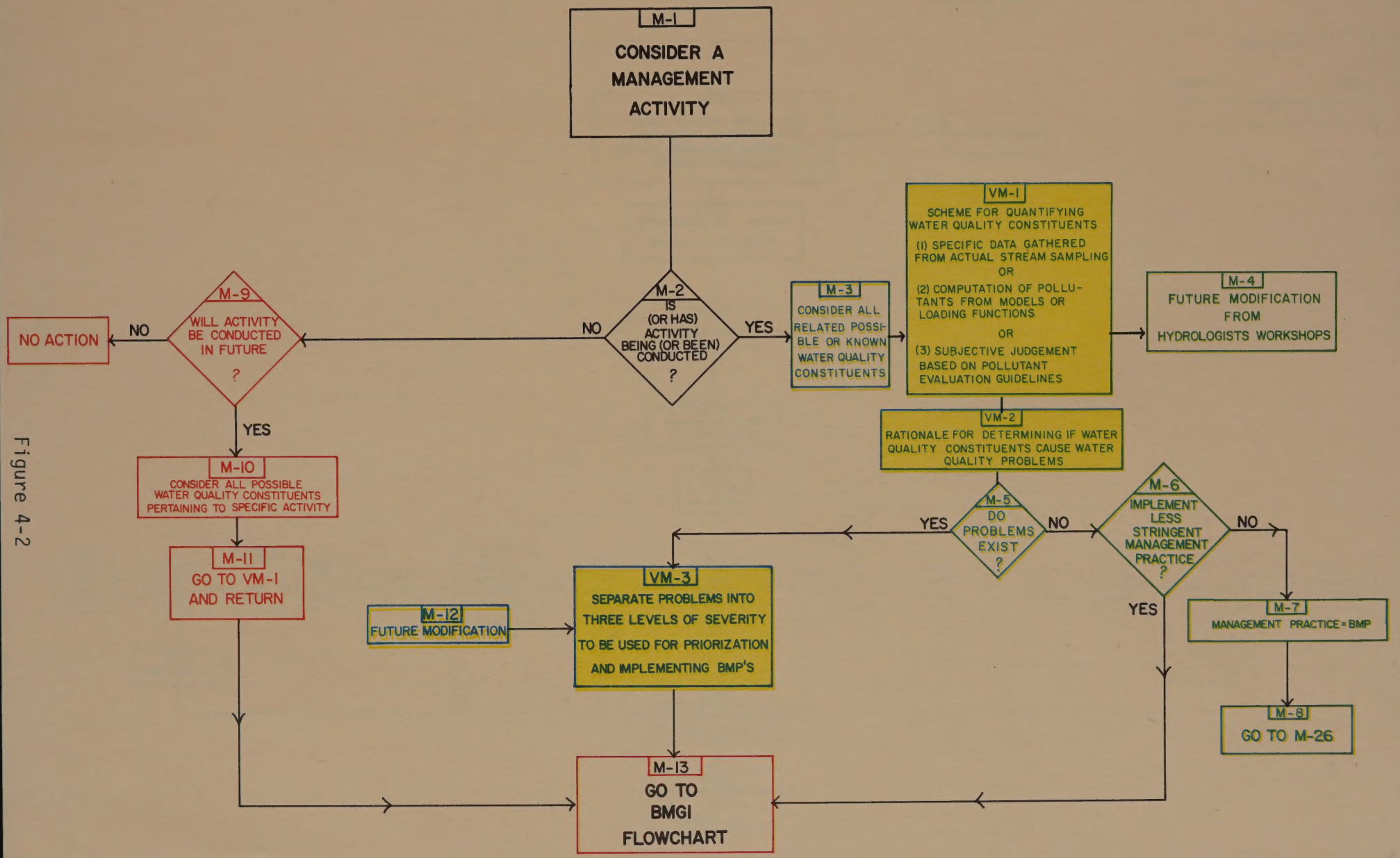
M-1
CONSIDER A MANAGEMENT ACTIVITY
M-2
IS (OR HAS) ACTIVITY BEING (OR BEEN) CONDUCTED ?
NO
YES
M-9
WILL ACTIVITY BE CONDUCTED IN FUTURE ?
NO
NO ACTION
YES
M-10
CONSIDER ALL POSSIBLE WATER QUALITY CONSTITUENTS PERTAINING TO SPECIFIC ACTIVITY
M-11
GO TO VM-1 AND RETURN
M-3
CONSIDER ALL RELATED POSSIBLE OR KNOWN WATER QUALITY CONSTITUENTS
VM-1
SCHEME FOR QUANTIFYING WATER QUALITY CONSTITUENTS
(1) SPECIFIC DATA GATHERED FROM ACTUAL STREAM SAMPLING
OR
(2) COMPUTATION OF POLLUTANTS FROM MODELS OR LOADING FUNCTIONS
OR
(3) SUBJECTIVE JUDGEMENT BASED ON POLLUTANT EVALUATION GUIDELINES
M-4
FUTURE MODIFICATION FROM HYDROLOGISTS WORKSHOPS
VM-2
RATIONALE FOR DETERMINING IF WATER QUALITY CONSTITUENTS CAUSE WATER QUALITY PROBLEMS
M-5
DO PROBLEMS EXIST ?
YES
NO
M-6
IMPLEMENT LESS STRINGENT MANAGEMENT PRACTICE ?
NO
YES
M-7
MANAGEMENT PRACTICE = BMP
M-8
GO TO M-26
M-12
FUTURE MODIFICATION
VM-3
SEPARATE PROBLEMS INTO THREE LEVELS OF SEVERITY TO BE USED FOR PRIORIZATION AND IMPLEMENTING BMP'S
M-13
GO TO BMGI FLOWCHART

Figure 4-2

BEST MANAGEMENT GUIDELINES
IMPROVEMENT FLOWCHART (BMGIF)

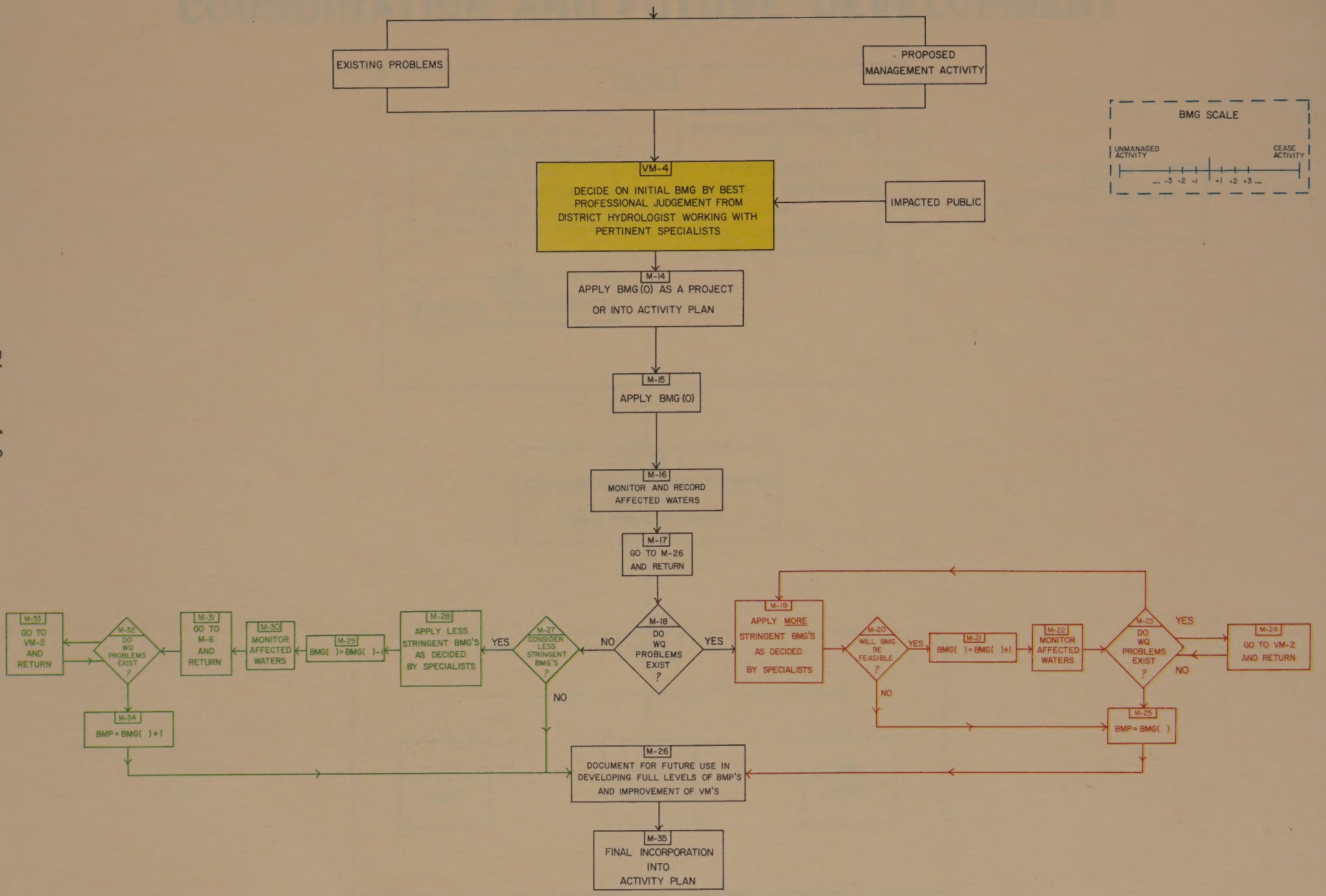

Figure 4-3

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COORDINATION AND FUTURE DEVELOPMENT

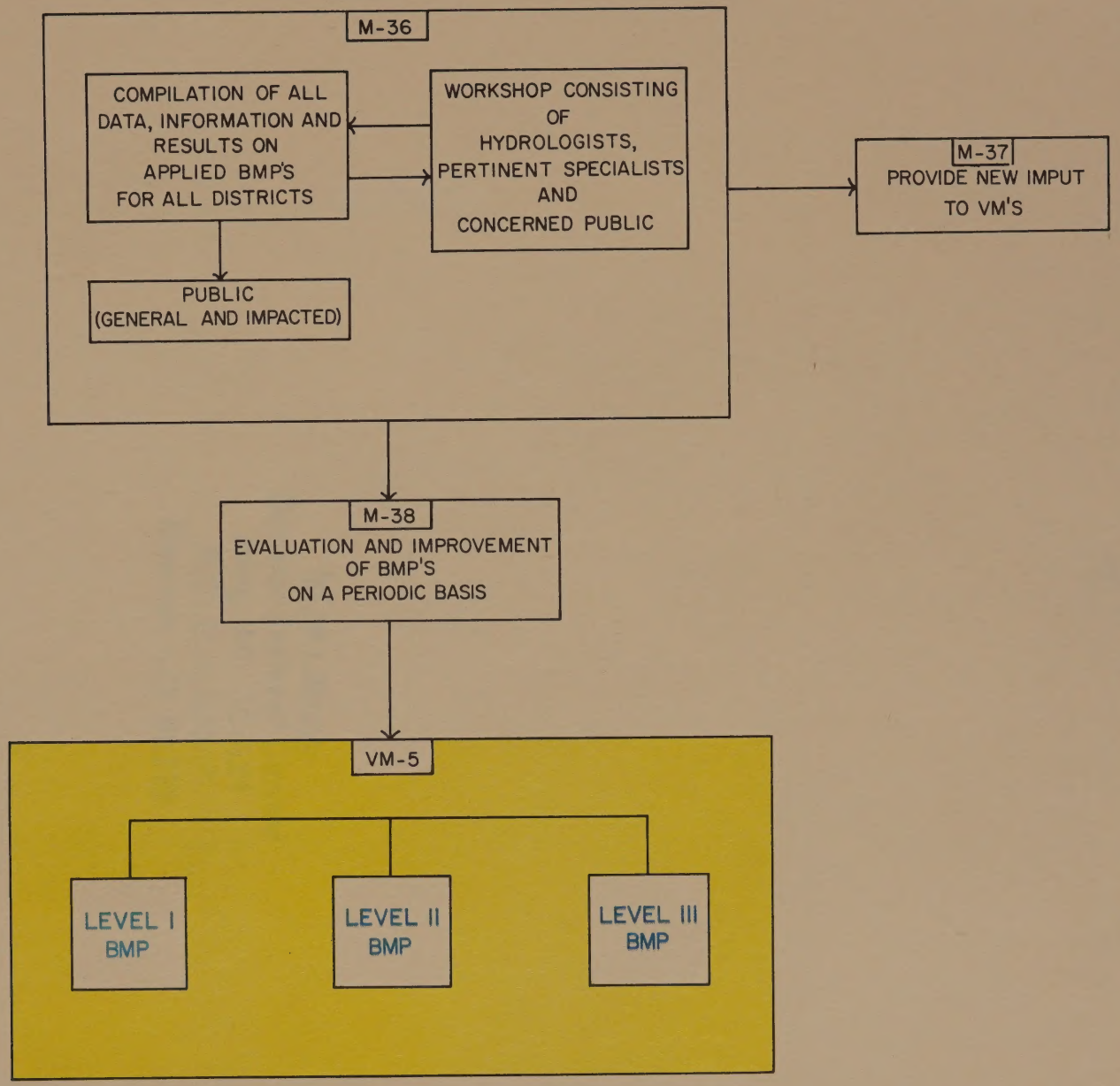
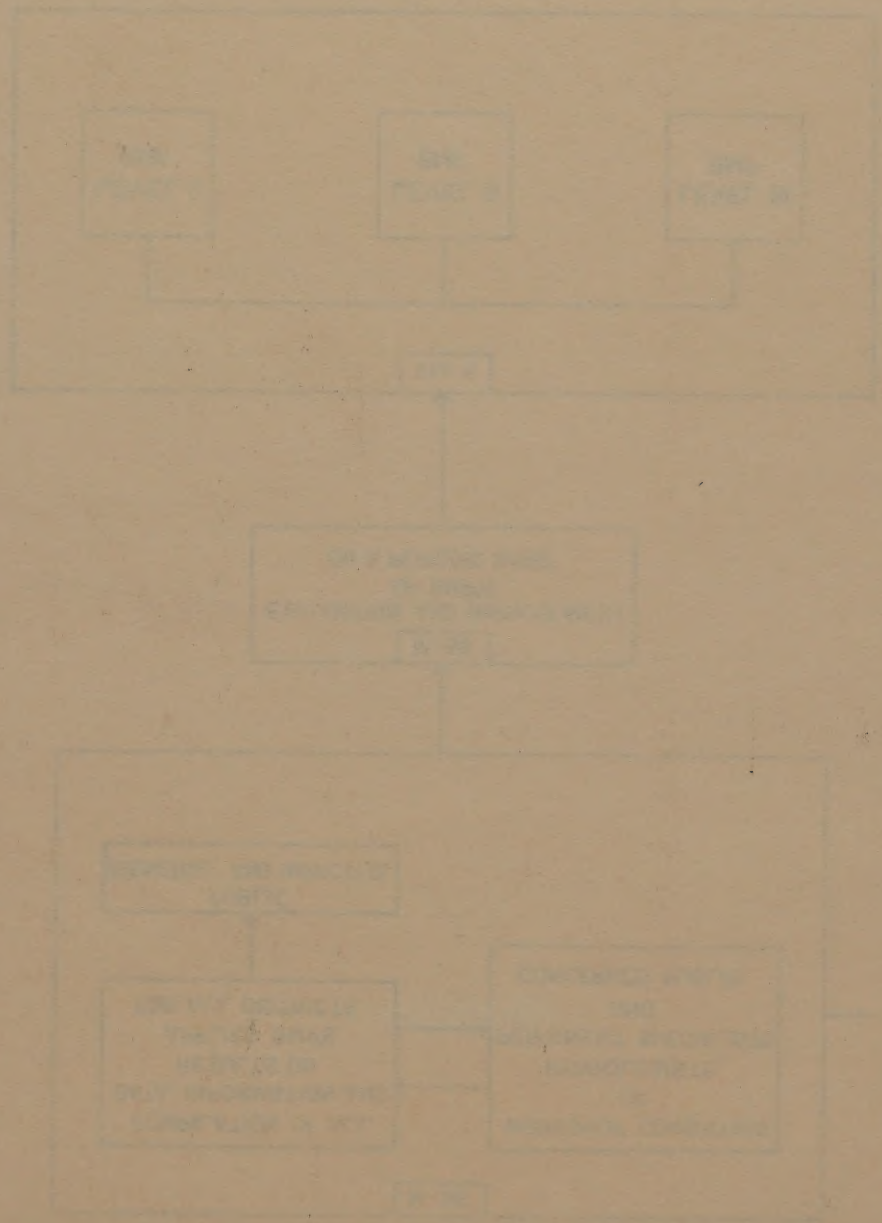

M-36
COMPILATION OF ALL DATA, INFORMATION AND RESULTS ON APPLIED BMP'S FOR ALL DISTRICTS
WORKSHOP CONSISTING OF HYDROLOGISTS, PERTINENT SPECIALISTS AND CONCERNED PUBLIC
PUBLIC (GENERAL AND IMPACTED)
M-37
PROVIDE NEW IMPUT TO VM'S
M-38
EVALUATION AND IMPROVEMENT OF BMP'S ON A PERIODIC BASIS
VM-5
LEVEL I BMP
LEVEL II BMP
LEVEL III BMP

Figure 4-4



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